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A CONTRIBUTION TO OUR KNOWLEDGE OF THE PYRENOMYCETES OF PORTO RICO[1]

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(WITH PLATES 13–15, AND TEXT FIGURES 1–4)

The study of the fungous flora of Porto Rico has received in recent years considerable attention from American mycologists. Their enthusiasm has been stimulated by the extensive collections made by Stevens, Fink, Whetzel and Olive, and has led to the publication of a series of papers which give us some conception of the richness of the mycological flora of the island. These studies are of importance, since they represent the first attempt on the part of American mycologists to gain a clearer knowledge of the fungi of the West Indies. A fairly complete account of the Uredinales has been presented in the publications of Arthur (2, 3) and Whetzel and Olive (22), but our knowledge of the pyrenomycetes is still far from perfect in spite of the numerous papers which have appeared dealing with the members of this group.

Klotzch and Sintenis seem to have been the first botanists to collect these fungi on the island and a list of their collections has appeared in literature (18, 26). Heller, in 1900, collected in quantity members of the group and distributed them in his Plants of Porto Rico. His specimens were studied by Earle, who published on them two papers (7, 8), which were the first contributions of importance. A number of years followed in which no

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further progress was made, but in 1913 a very active phase of the work was initiated by Stevens and has steadily progressed up to the present time. During 1913–15 Stevens made extensive collections of fungi and accumulated a large amount of material which is deposited at the herbarium of the University of Illinois. He has studied his collection in collaboration with some of his students, and they have published a number of papers on the pyrenomycetes (16, 21, 28, 29, 30, 31, 32, 33, 34, 35) in which a great number of new species have been described. Whetzel and Olive spent the spring of 1916 in the island collecting rusts and other parasitic fungi. A few of the pyrenomycetes of their collections have been described by Fitzpatrick (13, 14) and Seaver (25), and recently a list of all of them was published by the writer (6). A third extensive collection, consisting chiefly of lichens and ascomycetes, was made by Fink in the winter of 1915–16, but nothing has been published on it, excepting a preliminary note by him (12). However, a set of his collections has been sent to the writer, and a further study of them will certainly disclose a number of interesting forms. The pathologists at the Insular Experiment Station at Rio Piedras, P. R., have given a generous part of their time to the collection of fungi and their specimens are deposited at the Station Herbarium. A number of their pyrenomycetes have been sent to Seaver for identification.

Stevenson's "Check List of Porto Rican Fungi" (36), which is a compilation of all the species previously reported and widely scattered in literature, appeared in 1918. It constitutes a starting point for the study of the fungous flora of the island. This paper is rapidly going out of date, however, and the necessity for its revision is felt.

The writer, having become interested in the study of the pyrenomycetes, spent the summer of 1920 in the island collecting intensively on this group. Also the collections of Whetzel and Olive, Stevens, Fink and those of the Insular Experiment Station have been available to him. A close study of these has brought out a sufficient number of interesting facts to warrant the publication of this paper. It represents an attempt toward a more complete understanding of the insular forms of the group.

The writer wishes especially to acknowledge his obligation to Doctor F. J. Seaver and Doctor W. A. Murrill of the New York Botanical Garden for their courtesy and kindness during two brief visits there; to Mr. E. D. Colón, Director of the Insular Experiment Station, and to Mr. J. Matz and Mr. B. López, of the Plant Pathology staff, for their coöperation in connection with this work; to Doctor B. Fink, of Miami University, for having generously sent a set of his collections to the writer; to Doctor F. L. Stevens, of Illinois University, and Doctor C. R. Orton, of Pennsylvania State College, for courteous advice in correspondence. Thanks are due also to Doctor C. Ferdinandsen and Doctor C. Christendsen, of the University of Copenhagen, Denmark; to Doctor L. Romell, of the Royal Museum at Stockholm, Sweden, and to Doctor C. Spegazzini, of LaPlata, Argentine, for having supplied the writer with portions of type materials for examination in connection with this work. Finally, an expression of appreciation is due to Professor H. H. Whetzel, of the Department of Plant Pathology, Cornell University, for placing at the writer's disposal all of his collections, and to Professor H. M. Fitzpatrick, of the same department, under whose supervision the work has been conducted, for valuable suggestions and coöperation, and for the revision and correction of the manuscript. Thanks are also due to Mr. W. R. Fisher for the care taken in the preparation of the photographs which illustrate this paper.

PERISPORIALES

MICROTHYRIACEAE

Lembosia Lév.

This genus founded by Léveillé (19) was based on four species: *Lembosia. tenella, L. macula, L. Drymidis* and *L. Dendrochili.* Theissen (37) in his recent monograph considers *L. tenella* as the type of the genus and creates a number of additional genera, retaining in the old genus *Lembosia* only those forms having a superficial mycelium and paraphyses. He has reduced to synonymy two Porto Rican species described by Earle (7, 8). It is in the sense of Theissen that the genus is considered here.

The affinities of the genus are not well understood. Saccardo (23), Lindau (20) and Ellis and Everhart (9) have placed it in the Hysteriaceae, while Spegazzini (27) included it in the Hemihysteriaceae. Gaillard (15) first threw light on its real affinities. He shows that the formation of perithecia takes place very much as in *Asterina* and suggests that the genus be incorporated in the Microthyriaceae. Theissen and Sydow (40) definitely include it under that family.

KEY TO PORTO RICAN SPECIES

A. Colonies inconspicuous; spores small, 8–11 μ long.	*L. microspora*
B. Colonies very conspicuous, spores larger.	
1. Spores 28–35 μ long.	*L. melastomatum*
2. Spores 16–20 μ long.	
a. Hyphopodia present; on *Coccoloba*.	*L. tenella*
b. Hyphopodia absent; on *Agave*.	*L. Dendrochili*

Lembosia microspora sp. nov.

Colonies inconspicuous; mycelium very sparse, widely effused, hyphae septate at regular intervals, brown, 3–4 μ in diam., occasionally branched and anastomosing; hyphopodia absent; ascomata epiphyllous, scattered, black, very rarely confluent, linear, straight or more often curved, ends obtuse, 250–750 x 100–180 μ, in rare cases exceeding 1 mm. in length; asci ellipsoidal to subglobose, 8-spored, 19–23 x 10–13 μ; spores inordinate, rather unequally septate, hyaline, becoming dark brown at maturity, 8–11 x 4–5 μ; paraphyses inconspicuous (figs. 1–3).

Differs from all other known species of *Lembosia* in the small size of the spores. Another prominent feature is the inconspicuous character of the colonies due to the very scant development of mycelium.

MATERIAL EXAMINED:

On *Ocotea leucoxylon* (Sw.) Mez. (with an undetermined microthyriaceous form on the under surface of the leaf). Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 621, Maricao, Mar. 16, 1916 (*type*).

LEMBOSIA MELASTOMATUM Mont., Pl. Cellul. Cent. VII: 373.

Lembosia diffusa Winter Hedwigia **24**: 30. 1885.

The Porto Rican collections of this form have all been reported

as *L. diffusa*. The spore measurements given by different authorities vary. Ours, 26–33 x 11–14 μ, seem to agree with those of Arnaud (1) (figs. 4–6).

MATERIAL EXAMINED:

On *Miconia prasina* (Sw.) DC. Porto Rican fungi (Fink), No. 587, Rio Piedras, Dec. 2, 1915; Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 665, Maricao, Mar. 23, 1916.

LEMBOSIA TENELLA Léveillé, Ann. Sci. Nat. III (Bot.) 3: 58. 1845.

Lembosia Coccolobae Earle, N. Y. Bot. Gard. Bul. 3: 301, 302. 1903.

Theissen (37) has examined a portion of Earle's type and says: "Nach dem Blatt zu urteilen, ist die Matrix genau derselbe wie die Nicaragua-Exemplar von *Lembosia tenella;* der Pilz ist derselbe, die Art also synosym mit der von uns adoptierten Form von tenella" (figs. 7–8).

The species seems to be of common occurrence. It is unique in being able to withstand the most xerophytic conditions. The spores measure 15–21 x 6–7 μ.

MATERIAL EXAMINED:

On *Coccoloba uvifera* (L.) Jacq. Plants of Porto Rico (Heller), No. 6375, Santurce, Jan. 7, 1903 (*type*); Cornell University Explorations of Porto Rico (Whetzel & Olive), Nos. 522, 523, Mayaguez, Mar. 3, 1916; id. id. (Chardon), No. 836, Ponce, Sept. 6, 1920.

LEMBOSIA DENDROCHILI Léveillé, Ann. Sci. Nat. III (Bot.) 3: 59. 1845.

Lembosia Agaves Earle, Muhlenbergia 1: 15. 1900.

A characteristic species on account of its numerous black spots, which are slightly elevated. Earle's material is not fully matured, and he gives the spore measurements as 14–16 x 6–7 μ. Ferdinandsen and Winge (11) examined ripe material from Trinidad

and found the spores to measure 17–20 x 7–9 μ. The material collected by the writer does not show spores, but it is undoubtedly this species. Thiessen considers Earle's species to be identical with *L. Dendrochili*.

MATERIAL EXAMINED:

On *Agave* sp. Plants of Porto Rico (Heller), No. 4429, Cabo Rojo, Jan. 29, 1900 (*type*); Cornell University Explorations of Porto Rico (Chardon), No. 837, Penuelas, July 20, 1920.

HYPOCREALES

The system of Seaver (24) will be followed in this order.

NECTRIACEAE

HYPONECTRIA PHASEOLI Stevens, Bot. Gaz. **70**: 401. 1920.

Phyllachora Phaseoli P. Henn, *in* Chardon Mycol. **12**: 320. 1920.

The collection of this fungus previously reported by the writer as *Phyllachora* agrees perfectly with the description of Stevens's species.

MATERIAL EXAMINED:

On *Phaseolus adenanthus* Meyer. Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 659, Tamana River, Apr. 7, 1916.

CREONECTRIA OCHROLEUCA (Schw.) Seaver, Mycol. **1**: 190. 1909.

? *Creonectria grammicospora* (Ferd. & Wge.) Seaver, *in* Chardon Mycol. **12**: 319. 1920.

This species resembles *Creonectria Bainii* (Massee) Seaver in perithecial, ascus and spore characters; it differs in that the perithecia are flesh colored when young. The color soon changes to light yellow, and then it becomes impossible to tell the two apart. *Creonectria grammicospora* (F. & W.) Seaver is probably identical with *Creo. ochroleuca*, or represents a variety of it, but definite action in regard to this point can not be taken until the type materials of both species have been examined.

MATERIAL EXAMINED:

On dead bark and twigs. Porto Rican Fungi (Fink), No. 1135, Mayaguez, Dec. 21, 1915; Cornell University Explorations of Porto Rico (Whetzel & Olive), Maricao, Mar. 23, 1916. deposited in Chardon herbarium as No. 742; id. id. (Chardon), No. 888, Penuelas, July 20, 1920.

CREONECTRIA RUBICARPA (Cooke) Seaver, Mycol. 1: 187. 1909.
Nectria rubicarpa Cooke, Grevillea 7: 50. 1878.

The material examined, although scant, seems to agree with this species except in one character: the arrangement of the perithecia in cespitose clusters is not pronounced. Most of them are gregarious. The spores measure 10.5–12 x 5–6 μ.

MATERIAL EXAMINED:

On a log. Porto Rican Fungi (Fink), No. 215, Rio Piedras, Jan. 18, 1916; Cornell University Explorations of Porto Rico (Chardon), No. 889, Mayaguez, July 14, 1920.

Ophionectria portoricensis sp. nov.

Perithecia densely gregarious, cylindrical to subconical, slightly tapering above, 500–800 μ high, 250 μ in lateral diameter, scarlet, covered irregularly with a mealy substance which gives a warty appearance, naked toward the apex, possessing a distinct ostiolum, 15 μ in diam.; asci subcylindrical, tapering above and below, 217–274 x 22.5–28 μ, 8-spored, the ascus wall evanescent; spores filiform, curved, slightly tapering toward each end, contents hyaline and granular, 13–27 septate, 153–221 x 6–7.5 μ; paraphyses indistinct.

A very distinct and characteristic species on account of the unusually large spores and asci (fig. 10).

MATERIAL EXAMINED:

On a log. Cornell University Explorations of Porto Rico (Whetzel & Olive), Mayaguez, Mar. 13, 1916. deposited in Cornell University Department of Plant Pathology herbarium as No. 11129 (*type*).

HYPOCREACEAE

Podostroma orbiculare sp. nov.

Stromata stipitate or substipitate, orbicular, convex, yellowish brown, white and woody within, 4–6 mm. in diam., 2–3.5 mm. high, the surface minutely rugulose from the slightly protruding ostiola; stem stout, short, not exceeding 2 mm. in diam.; perithecia entirely immersed in the stroma, 120–180 μ in diam.; asci cylindrical, 50–60 x 4 μ, becoming 16-spored at maturity; spores subglobose, hyaline, 2.5 x 3 μ; paraphyses present (fig. 11).

This beautiful species is unique in having a woody stroma instead of the fleshy or subfleshy stroma common to this and other allied genera. It is placed in *Podostroma* rather than in *Hypocrea*, since the stroma is stipitate.

MATERIAL EXAMINED:

On a decaying log. Porto Rican Fungi (Fink), No. 239, Mayaguez, Dec. 17, 1915 (*type*).

STILBOCREA HYPOCREOIDES (Kalch. & Cooke) Seaver, Mycol. **2**: 62. 1910.

? *Stilbocrea intermedia* Ferd. & Wge., Bot. Tidsk. **29**: 12. 1908.

This species is very closely related to *S. intermedia*, from which it can, in fact, hardly be distinguished. Seaver (**24**) separates the two forms on the basis of spore measurements, but the difference is so slight as to raise the question whether the two may not be identical.

MATERIAL EXAMINED:

On bark and decaying wood. Herbarium Insular Experiment Station (Stevenson), No. 2390, Rio Piedras, Nov. 29, 1914; Cornell University Explorations of Porto Rico (Chardon), No. 1237, Mayaguez, July 14, 1920.

Dothichloe Atk.

This genus comprises a few forms parasitic on grasses. It was erected by Atkinson (**4, 5**) to include those species of *Hypocrella* possessing a dothideaceous stroma like *Dothichloe atramentosa* (B. & C.) Atk.

The systematic position of the genus is not definitely established. It is included in the Hypocreales by Seaver (24) as a synonym of *Balansia.* Since Seaver does not discuss any of the species of *Dothichloe* under *Balansia,* there appears to be no justification for this. *Dothichloe* is distinct from *Balansia* in not possessing a pseudosclerotium made up of a mixture of host and fungous tissue. Theissen and Sydow (39) exclude the genus from the Dothideales and regard it as identical with *Ophiodothis.* Stevens in his "Fungi Which Cause Plant Disease" assigns it a definite place in the Hypocreales, placing it next to *Balansia.* The writer has examined a set of prepared slides made from the type specimen of *Hypocrea atramentosa* B. & C. which are deposited in the Atkinson herbarium at Cornell University. The stroma is evidently dothideaceous and no evidence of a perithecial wall is present. However, in their filiform spores and in certain other minor characters the species show marked resemblance with those of *Balansia, Epichloe* and *Hypocrella,* and thus a relationship with the Hypocreaceae is strongly suggested.

KEY TO PORTO RICAN SPECIES

A. Stromata distinct, subglobose, located below the nodes of the host. *D. subnodosa*

B. Stromata broadly effused.
   1. Stromata completely encircling the culms. *D. Aristidae*
   2. Stromata borne on the leaf and occupying only one side. *D. atramentosa*

Dothichloe subnodosa sp. nov.

Balansia subnodosa Atk., in mss.

Dothichloe nigricans (Speg.) Seaver, *in* Stevenson, Jour. Dept. Agr. Porto Rico **2**: 151. 1918.

Stromata subglobose, slightly flattened, located just beneath the nodes on the culms of the host, partially or in rare cases entirely surrounding the host, black, brown or yellowish within, not united with the host elements, 1–3 mm. in diam., with the surface rugulose from the papillate ostiola; locules immersed, flask-shaped, 125–150 x 150–200 μ; asci narrowly cylindrical, tipped with a globose "cap cell," 150–180 x 3–4.5 μ, 8-spored; spores filiform, nearly as long as the asci, approximately 1 μ broad, fragmenting at maturity; paraphyses present (fig. 14).

This fungus is clearly different from *Epichloe* ? *nigricans* Speg., which has stromata 5–10 mm. long. Atkinson worked with one of Stevens's collections of this form and labeled it in his herbarium

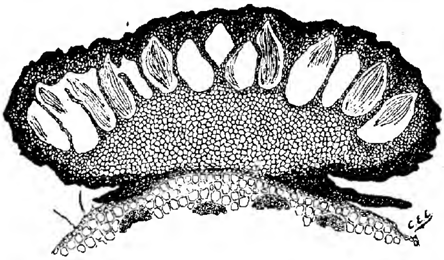

FIG. 1. *Dothichloe subnodosa* sp. nov. Cross section of a stroma showing the sharp definition between the host and fungous tissue. (Outlined with a camera lucida; × 50).

as "*Balansia subnodosa* sp. nov." He apparently, however, never published it. The writer feels that the species should be transferred to *Dothichloe* on account of the absence of the intimate fusion of fungous and host tissue, pseudosclerotium, characteristic of *Balansia*.

MATERIAL EXAMINED:

On *Ichnanthus pallens* Munro. Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 690, Mayaguez, Mar. 6, 1916 (*type*); id. id. (Whetzel & Olive), No. 689, Mayaguez, Mar. 2, 1916; id. id. (Whetzel & Olive), No. 692, Maricao, Mar. 22, 1916; id. id. (Whetzel & Olive), No. 691, El Yunque, Apr. 22, 1916.

DOTHICHLOE ARISTIDAE Atk., Bul. Torr. Bot. Club 21: 224. 1894.

Characteristic in that the stroma completely surrounds the culms of the host, as in *Epichloe*. However, the stromata are black and carbonaceous (fig. 13).

MATERIAL EXAMINED:

On *Aristida portoricensis* Pilger. Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 695, Mayaguez, Mar. 7, 1916.

DOTHICHLOE ATRAMENTOSA (B. & C.) Atk., Jour. Mycol. **11**: 260. 1905.

Hypocrea atramentosa B. & C., Jour. Linn. Soc. **10**: 377. 1869.

Stromata 5–15 mm. long, black, carbonaceous, occupying only one side of the leaf. Very distinct from the preceding species (fig. 12).

MATERIAL EXAMINED:

On *Andropogon leucostachys* H. B. K. Herbarium University of Illinois, Porto Rican Fungi (Stevens), No. 8211, Las Marias, July 10, 1915.

On *Chloris petraea* Sw. Cornell University Explorations of Porto Rico (Whetzel & Olive), Nos. 694, 694*a*, Boqueron, Mar. 11, 1916.

DOTHIDEALES

The system of Theissen and Sydow (39) will be followed here in its entirety.

DOTHIDEACEAE

Dothidina peribebuyensis (Speg.) comb. nov.

Phyllachora peribebuyensis Speg., Fung. Guar. **1**: 274. 1883.

Auerswaldia Miconiae P. Henn., Hedwigia **43**: 253. 1904.

Bagnisiopsis peribebuyensis (Speg.) Th. & Syd., Ann. Mycol. **13**: 292. 1915.

Dothidina Miconiae (P. Henn.) Th. & Syd., Ann. Mycol. **13**: 298. 1915.

A comparison of the type material of *Phyllachora peribebuyensis* Speg. (Balansa—Plantes du Paraguay No. 3854) and that of *Auerswaldia Miconiae* P. Henn. (Ule—Appendix Mycotheca Brasiliensis No. 27) has shown them to be the same fungus. Theissen and Sydow seem to have overlooked this fact and have proposed new combinations for each, placing them under different genera.

The fungus is by no means a *Phyllachora*. Garman (**16**) identified the specimens collected by Stevens as *P. peribebuyensis*, but admitted that the species might possibly fall under *Bagnisiopsis*. Working with material from Colombia, H. and P. Sydow (**41**) also made the mistake of referring the fungus to *P. peribebuyen-*

sis. They observed, however, that the spores at maturity turn to a light brown color, which suggested to them the genus *Auerswaldia*. Finally Seaver determined the specimens collected by Whetzel and Olive as *Auerswaldia Miconiae* and the writer (6) published them under that name (fig. 19).

The fungus falls under *Dothidina* in the treatment of Theissen and Sydow on account of the presence of paraphyses. The spores measure 14–18 x 6–7 μ.

MATERIAL EXAMINED:

On *Heterotrichum cymosum* (Wendl.) Urban. Herbarium University of Illinois, Porto Rican Fungi (Stevens), No. 5206, San Sebastian, Nov. 13, 1913; Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 643, El Yunque, Apr. 12, 1916.

On *Miconia laevigata* (L.) DC. Herbarium University of Illinois, Porto Rican Fungi (Stevens), No. 435, El Gigante, Dec. 15, 1913.

On *Miconia prasina* (Sw.) DC. Herbarium Insular Experiment Station (Stevenson), No. 5362, Espinosa, Mar. 27, 1917.

On *Miconia Sintenisii* Cogn. Herbarium University of Illinois, Porto Rican Fungi (Stevens), No. 6656, Santa Ana, Dec. 31, 1913.

On *Miconia* sp. Herbarium Insular Experiment Station (Stevenson), No. 742, Maricao, Mar. 14, 1913; Cornell University Explorations of Porto Rico (Whetzel & Olive), Nos. 696, 697, Maricao, Mar. 22 and 15, 1916, respectively.

On *Tetrazygia elaeagnoides* (Sw.) DC. Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 636, Barceloneta, Apr. 8, 1916.

PHYLLACHORACEAE

Trabutia Bucidae sp. nov.

Spots not exceeding the stromata; stromata numerous, hypophyllous, crowded in irregular areas 5–10 mm. in diam., individual stromata black, shining, approximately circular, often confluent, .5–1.5 mm. in diam., subcuticular; locules globose to oblong, 200–300 x 150–200 μ, covered by a well-developed stroma which often

extends far beyond them; asci very indistinct, clavate cylindrical, 8-spored, 50–64 x 17–24 μ; spores inordinate, continuous, pale yellow, globose to ellipsoidal, 9–12 x 7–8 μ; paraphyses present, profuse (fig. 22).

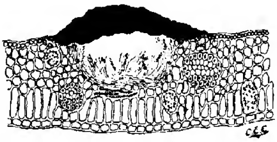

FIG. 2. *Trabutia Bucidae* sp. nov. Cross section of a leaf of *Bucida buceras* showing a locule covered above with a subcuticular stroma. (Outlined with a camera lucida; X 125).

MATERIAL EXAMINED:

On *Bucida buceras* L. Cornell University Explorations of Porto Rico (Chardon), No. 905, Coamo. Aug. 21, 1921 (*type*).

Trabutia Guazumae sp. nov.

?*Phyllachora Guazumae* P. Henn., Hedwigia **48**: 7. 1908.

Stromata epiphyllous, numerous, black, shining, irregular or occasionally circular, distinctly convex to subconical, 1–2 mm. in diam., in rare cases 3–4 mm., surrounded by a discolored zone of dead host tissue .5 mm. across; locules many, globose, 200–300 μ in diam.; covered with a well-developed stroma, asci subcylindrical, 63–78 x 13–19 μ; the ascus wall indistinct, spores uniseriate or biseriate in the main body of the ascus, cylindrical, hyaline, continuous, contents uniform when young, becoming distinctly 2-guttulate at maturity; paraphyses present (fig. 20).

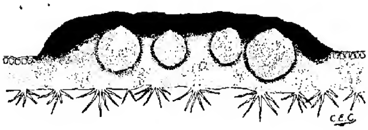

FIG. 3. *Trabutia Guazumae* sp. nov. Cross section of a leaf of *Guazuma ulmifolia* showing plurilocular stroma. The stroma is apparently subcuticular. (Outlined with a camera lucida; X 125).

This form is probably cospecific with *Phyllachora Guazumae* described by Hennings from Brazil. Unfortunately, he worked with immature material and his description is very incomplete, the spores not being mentioned. In the system of Theissen and

Sydow the Porto Rican material falls in the genus *Trabutia* on account of the subcuticular stroma.

MATERIAL EXAMINED:

On *Guazuma ulmifolia* Lam. Cornell University Explorations of Porto Rico (Chardon), No. 895, Penuelas, Aug. 11, 1920 (*type*); id. id. (Chardon), No. 921, Penuelas, July 28, 1920.

Trabutia conica sp. nov.

Stromata epiphyllous, numerous, shining, black, approximately circular, conical and protruding considerably above the surface of the host, 1–2 mm. in diam., subcuticular (?), surrounded by a slightly discolored zone 1 mm. across, the single ostiolum distinct at the apex of the conical stroma; locule single, 300–700 μ in diameter, at first bearing a thick layer of filiform, hyaline conidia, 3–4 x 1 μ, later developing the asci; asci narrowly ellipsoidal, 8-spored, 67–81 x 19–23 μ, the ascus wall indistinct, spores biseriate to inordinate, globose, hyaline, continuous, 10 μ in diam.; paraphyses present (fig. 21).

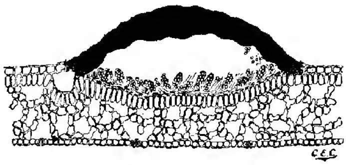

FIG. 4. *Trabutia conica* sp. nov. Cross section of a leaf of *Drepanocarpus lunatus* showing a locule, the subcuticular stroma, asci and ascospores. (Outlined with a camera lucida; × 125).

MATERIAL EXAMINED:

On *Drepanocarpus lunatus* (L. f.) G. Meyer. Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 658, Mayaguez, Mar. 26, 1916 (*type*); id. id. (Whetzel & Olive), No. 634, Martin Pena, Apr. 10, 1916.

Phyllachora canafistulae Stevens & Dalbey, Bot. Gaz. **68**: 55. 1919.

The description of this fungus by Stevens and Dalbey was based

on a single collection made at Mayaguez on *Cassia fistula*. The writer was fortunate in securing abundant material of the species and, moreover, collecting it on a new host, *Cassia grandis*. *Phyllachora Cassiae* P. Henn. reported from Brazil is very distinct from the Porto Rican species in possessing smaller, unilocular stromata and slightly larger spores. The two collections reported by Stevenson (36) as *P. Cassiae* are here referred to *P. canafistulae* (fig. 23).

MATERIAL EXAMINED:

On *Cassia fistula* L. Herbarium Insular Experiment Station (Stevenson), No. 3564, Rio Piedras, Dec. 14, 1915; Cornell University Explorations of Porto Rico (Chardon), No. 924, Penuelas, July 30, 1920; id. id. (Chardon), No. 926, Penuelas, July 18, 1920.

On *Cassia grandis* L. Cornell University Explorations of Porto Rico (Chardon), No. 900, Penuelas, July 18, 1920; id. id. (Chardon), No. 916, Penuelas, July 24, 1920.

Phyllachora Serjaniicola sp. nov.

Spots amphigenous, slightly exceeding the stromata, irregular; stromata small, black, shining, 1–4 mm. in diam., visible on both sides of the leaf, occupying the mesophyll, surrounded by a narrow zone of dead host tissue, plurilocular; locules globose to irregular, 180–300 μ in diam.; asci cylindrical, 8-spored, 63–75 x 12–18 μ; spores uniseriate or else biseriate at the apex, ellipsoidal, hyaline, continuous, 10–13 x 6–8 μ; paraphyses present (fig. 18).

The species differs from *Phyllachora duplex* Rehm in having smaller spores and much smaller stromata. A portion of Rehm's type was sent by Doctor L. Romell for examination.

MATERIAL EXAMINED:

On *Serjania polyphylla* Radlk. Cornell University Explorations of Porto Rico (Chardon), No. 923, Penuelas, July 27, 1920 (*type*); id. id. (Chardon), No. 896, Penuelas, Aug. 11, 1920.

Phyllachora Whetzelii sp. nov.

Spots amphigenous, slightly exceeding the stromata, circular in outline; stromata small, purple-black, dull, circular, 1–1.5 mm. in diam., occupying the mesophyll of the leaf; very conspicuous on

the upper surface, slightly less so on the lower; locules globose, 2–4 in each stroma, 150–250 μ across; asci cylindrical, 87–109 x 8–10.5 μ, 8-spored; spores uniseriate, ellipsoidal, hyaline to yellowish green, continuous, 11.5–13 x 3–4 μ; paraphyses very abundant (fig. 24).

This species possesses some of the characters of *Phyllachora biareolata* Speg., but, through the courtesy of Doctor C. Spegazzini, it has been possible to examine a portion of the type material of that species, and our form has been found to be very different in stromatal characters.

MATERIAL EXAMINED:

On *Eugenia* sp. Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 571, Barceloneta, Apr. 6, 1916 (*type*).

SPHAERIALES

SORDARIACEAE

Only one species belonging to this group of dung-inhabiting forms has been reported from the island. The group is probably well represented, but has apparently been neglected by all collectors. The writer has been fortunate in seeing two collections in excellent condition. Both of them have been identified with the aid of Griffiths's monograph (17).

SORDARIA HUMANA (Fuckel) Awd., Abhand. naturf. Gess. Halle **13**: 85. 1873.

Spores obovate, 15–19 x 21–23 μ. According to Griffiths, the shape of the spores is the only character which serves to distinguish this species from *S. fimicola*, the spores of the latter being ellipsoidal.

MATERIAL EXAMINED:

On human dung. Cornell University Explorations of Porto Rico (Whetzel & Olive), Maricao, Mar. 16, 1896, deposited in Chardon herbarium as No. 1351.

PLEURAGE ARACHNOIDEA (Niessl.) D. Griff., Mem. Torr. Bot. Club **11**: 73. 1901.

Spores 7–9 x 17–19.5 μ, with a very long primary appendage which curves and overlaps the spore below.

MATERIAL EXAMINED:

On cow dung. Porto Rican Fungi (Fink), No. 1241, Mayaguez, Dec. 3. 1915.

SPHAERIACEAE

HERPOTRICHIA ALBIDOSTOMA (Schw.) Sacc., Syll. Fung. 9: 857. 1891.

There have been thus far only four collections of *Herpotrichia* made from the island: two of them collected by Stevenson and two by the writer. Stevenson (37) refers one of his collections to *H. albidostoma* and the other to *H. diffusa*. All four collections have been examined by the writer and it has become evident that they belong to a single species. This conclusion was reached after measuring accurately 100 spores from each specimen and plotting curves which coincide. A wide range in spore lengths, 26 to 40 μ, was observed. The specimens agree with material collected by Langlois in Louisiana and distributed (Ellis & Everh., Fungi Columbiani, No. 1035) under the name of *Herpotrichia diffusa* var. *rhodomphala*. The Porto Rican material, however, is referred here to *H. albidostoma*, the type of which has been examined at the New York Botanical Garden.

MATERIAL EXAMINED:

On shells and debris of *Cocos nucifera* L. Herbarium Insular Experiment Station (Stevenson), No. 2626, Espinosa, Mar. 6, 1915; Cornell University Explorations of Porto Rico (Chardon), No. 1230, Mayaguez, July 14, 1920.

On decaying wood. Herbarium Insular Experiment Station (Stevenson), No. 5586, Rio Piedras, July 4, 1916; Cornell University Explorations of Porto Rico (Chardon), No. 959, Coamo, Aug. 26, 1920.

XYLARIACEAE

HYPOXYLON ANNULATUM (Schw.) Mont., Syll. Crypt.: 213.

This very common species resembles a *Rosellinia*, since the perithecia are sometimes free. Individual perithecia are large, black and bear the papilliform ostiolum at the center of a small disk (fig. 15).

MATERIAL EXAMINED:

On dead wood. Herbarium Insular Experiment Station (Stevenson), No. 2989, Palo Seco, Apr. 24, 1915; Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 764, Maricao, Mar. 13, 1916; id. id. (Chardon), Nos. 953, 963, Coamo, Aug. 23, 1920; id. id. (Chardon), No. 961, Coamo, Aug. 26, 1920.

NUMMULARIA CINCTA Ferd. & Wge., Bot. Tidsk. **29**: 15. 1909.

This form might be confused easily with *N. Bulliardi* in that the stroma is erumpent and pushes the bark to the sides. It differs in that the stroma lacks marked punctulations and is not so characteristically convex (fig. 17).

MATERIAL EXAMINED:

On dead and decaying wood. Herbarium Insular Experiment Station (Stevenson), No. 3464, Rio Piedras, Dec. 12, 1913; id. id. (Johnston & Stevenson), No. 1253, Martin Pena, Jan. 25, 1914; Porto Rican Fungi (Fink), No. 691, Rio Grande, Dec. 7, 1915; Cornell University Explorations of Porto Rico (Chardon), No. 977, Penuelas, July 21, 1920.

The material examined was compared with a fragment of the type kindly supplied by Doctor Ferdinandsen.

NUMMULARIA PUNCTULATA (B. & R.) Sacc., Syll. Fung. **1**: 399. 1882.

This is a very common and characteristic species on account of its smooth and polished stromata. The stroma is broadly effused, 3–10 cm. or more in length and projects but slightly above the bark. Most of the collections are sterile (fig. 16).

MATERIAL EXAMINED:

On dead wood. New York Botanical Garden, Explorations of Porto Rico (Schafer), No. 3687, Sierra de Naguabo, Aug. 10–15, 1914; Herbarium University of Illinois, Porto Rican Fungi (Stevens), No. 112, Dos Bocas, July 8, 1915; Porto Rican Fungi (Fink), No. 974, Mayaguez, Dec. 18, 1915; id. id. (Fink), No. 1785, Aibonito, Jan. 3, 1915; Cornell University Explorations of

Porto Rico (Chardon), No. 976, Penuelas, July 28, 1920; id. id. (Chardon), No. 979, Penuelas, Aug. 7, 1920.

NUMMULARIA REPANDA (Fries) Nitsch. Pyren. Germ: 57. 1867.

Very similar in habit to *N. discreta*, but with ellipsoidal spores, 11–13.5 x 4.5–6.5 μ.

MATERIAL EXAMINED:

On dead wood. Herbarium Insular Experiment Station (Johnston), No. 676, El Yunque, Dec. 12, 1912; Cornell University Explorations of Porto Rico (Chardon), No. 981, Coamo, Aug. 27, 1920.

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EXPLANATION OF PLATES

PLATE 13

Fig. 1. *Lembosia microspora* sp. nov. Group of ascomata; notice there is no evidence of a superficial mycelium. × 11.

Fig. 2. *L. microspora.* Two mature asci; notice the small size of the ascospores when compared with those of the other two species. × 300.

Fig. 3. *L. microspora.* Portion of a leaf of *Ocotea leucoxylon* showing groups of ascomata. × 8/11.

Fig. 4. *Lembosia melastomatum* Mont. Colonies on a fragment of a leaf of *Miconia prasina.* × 8/11.

Fig. 5. *L. melastomatum.* Group of ascomata on the same leaf; notice the profuse development of aerial mycelium. × 11.

Fig. 6. *L. melastomatum.* A mature ascus. × 300.

Fig. 7. *Lembosia tenella* Lév. Group of ascomata on a leaf of *Coccoloba uvifera.* × 11.

Fig. 8. *L. tenella.* An ascus with immature ascospores to the left and two mature ascospores to the right. × 300.

Fig. 9. *L. tenella.* Portion of a leaf of *Coccoloba uvifera* showing characteristic colonies. × 8/11.

PLATE 14

Fig. 10. *Ophionectria portoricensis* sp. nov. A group of perithecia. × 3.

Fig. 11. *Podostroma orbiculare* sp. nov. Two stromata: the one to the left is shown side view and shows the stipitate character. × 3/2.

Fig. 12. *Dothichloe atramentosa* (B. & C.) Atk. Characteristic stromata on leaves of *Chloris petraea.* × 8/11.

Fig. 13. *Dothichloe Aristidae* Atk. Culms of *Aristida portoricensis* with stromata completely encircling them. × 8/11.

Fig. 14. *Dothichloe subnodosa* sp. nov. Stromata on culms of *Ichnanthus pallens;* notice the location of the stromata just beneath the nodes. × 8/11.

Fig. 15. *Hypoxylon annulatum* (Schw.) Mont. Perithecia. × 6.

Fig. 16. *Nummularia punctulata* (B & R.) Sacc. Stromata on dead wood showing effused character; notice also the smooth polished surface of the stroma. × 8/11.

Fig. 17. *Nummularia cincta* Ferd. & Wge. Stromata on dead wood showing characteristic erumpent habit. × 8/11.

PLATE 15

Fig. 18. *Phyllachora Serjaniicola* sp. nov. Stromata on leaves of *Serjania polyphylla.* × 8/11.

Fig. 19. *Dothidina peribebuyensis* (Speg.) Chardon. Stromata on portion of a leaf of *Miconia* sp. × 8/11.

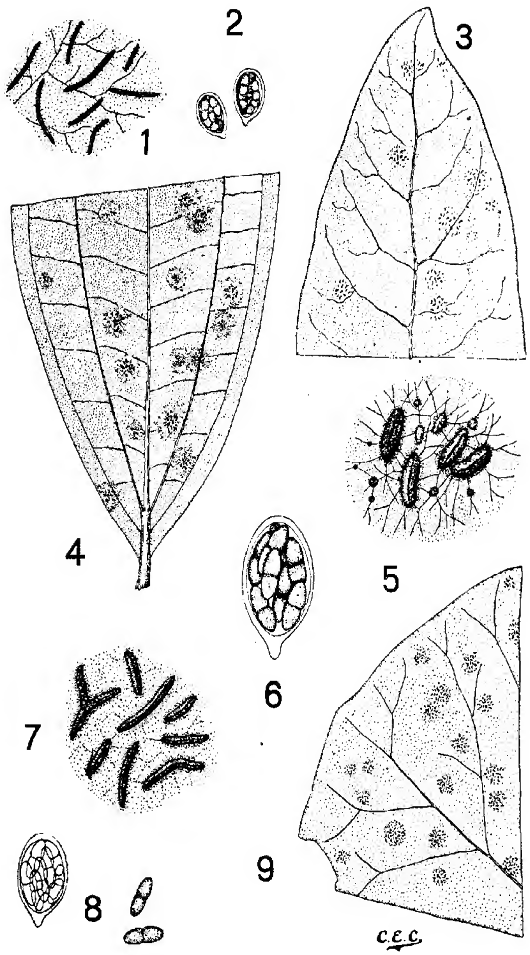
Fig. 20. *Trabutia Guazumae* sp. nov. Fragment of a leaf of *Guazuma ulmifolia* covered with numerous stromata. × 8/11.

Fig. 21. *Trabutia conica* sp. nov. Characteristic stromata on leaves of *Drepanocarpus lunatus.* × 8/11.

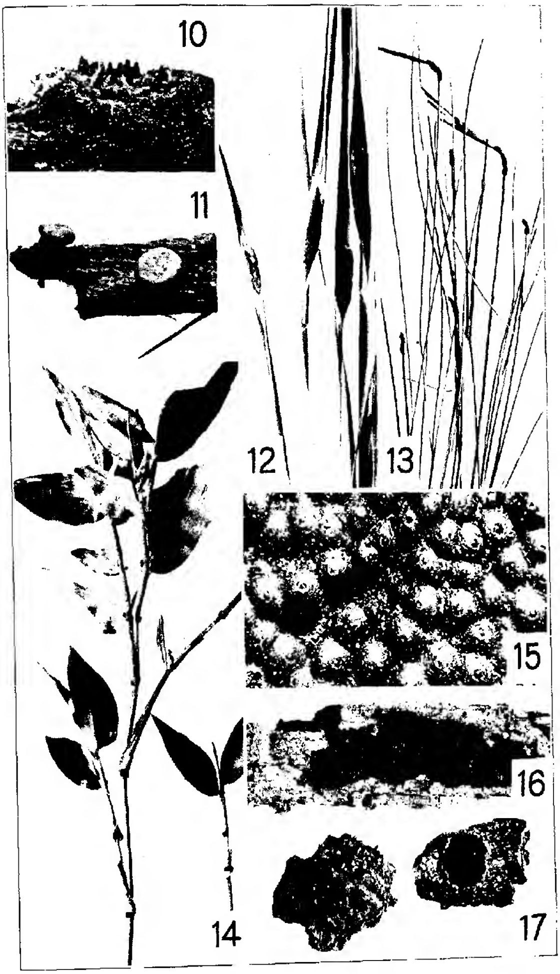
Fig. 22. *Trabutia Bucidae* sp. nov. Leaf of *Bucida buceras* with stromata; notice the stromata have a tendency to crowd themselves in colonies. × 8/11.

Fig. 23. *Phyllachora canafistulae* Stevens & Dalby. Stromata on leaves of *Cassia grandis.* × 8/11.

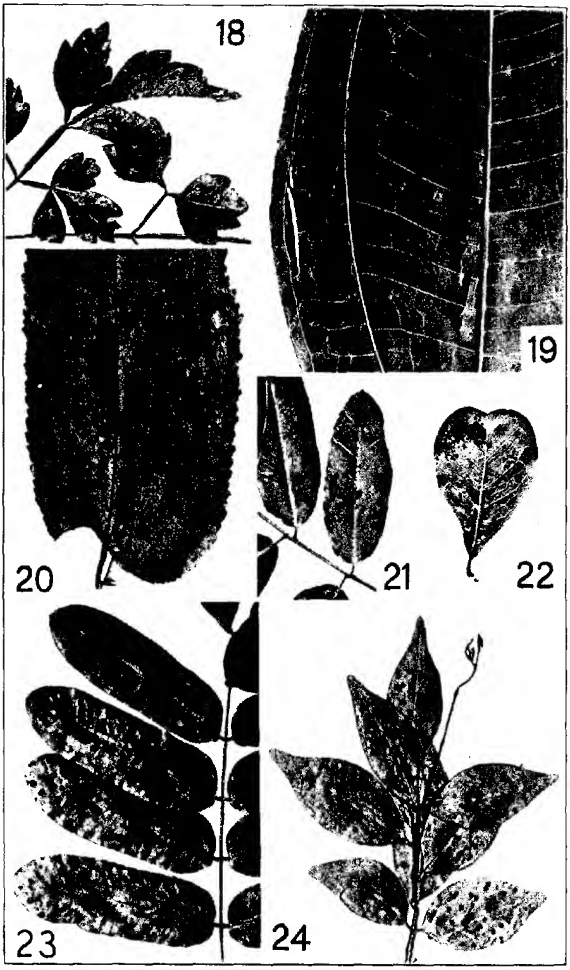
Fig. 24. *Phyllachora Whetzelii* sp. nov. Leaves of *Eugenia* sp. with stromata; notice the circular shape of the stromata. × 8/11.



Lembosia



HYPOCREALES AND SPHAERIALES



DOTHIDEALES

CALIFORNIA HYPOGAEOUS FUNGI—TUBERACEAE

Harold E. Parks

The hypogaeous fungi of America form a large, important and little known group. Practically nothing is known of the range of species or their distribution, their edibility or their life histories. Their occurrence in most cases has been noted rather by accident than through any careful or systematic search for them. In California there has been some definite attempt at extensive collection and study of the many different species.

The work was pioneered by Dr. H. W. Harkness. His work was left incomplete, however, at the time of his death and subsequently much of it was lost. It was successful in demonstrating the great variety and extent of the group. The work was then taken up by Dr. W. A. Setchell and Prof. N. L. Gardner, of the University of California, at Berkeley. The only literature available as a guide to the Californian species is the paper of Dr. Harkness, which is, unfortunately, not easily procured. The work is of little value in many ways, as the descriptions have been abbreviated. Dr. Helen M. Gilkey has made a careful "Revision of the Tuberales of California," which is an excellent account of ascomycetous forms. Drs. Zeller and Dodge have also recently published some accounts of the various Hymenogastrales in which are included numerous Californian species.

All of the recent publications will in time have to be revised more or less to include numerous additional species and allow of a modification of the published species. Aside from the paper of Dr. Harkness, there is no literature published which would be of service to the collector in the field. As in the case of the writer, the collectors must go at the work more or less blindly until experience has been gained. With all due allowances for seasonal differences, it is hoped that the following account will be of value to other collectors.

The collection of the hypogaeous fungi of the Santa Cruz Mountains, of California, is based upon a deliberate, carefully planned and systematic search. The writer has now the experience of six seasons' intensive exploration of the mountains adjacent to San Jose. It is a deliberate search that few would persist in season after season over the same ground, yet it becomes a most fascinating game at which to play.

The work begins with the coming of the fall rains and continues all through the winter months and up to the beginning of summer, when the ground becomes too dry for any fungus growths. If the ground is thoroughly covered, it frequently means the crawling into wet thickets on hands and knees and includes all the brambles, briars, poison oak and wood ticks that go along with such experiences. Sometimes the rewards from a mycological standpoint are well worth the effort. The most productive season comes in warm spring months if there has been a fair amount of rain. In some seasons there is little to be found owing to drought. Even if a goodly amount of rain has fallen and a sudden, protracted hot spell follows, the fungi will quickly disappear.

Californian Tuberaceae have been considered in the past to contain no aromatic species. Many of the species are easily detected in the soil by their conspicuous color, but some are rather difficult to find for the same reason. None were supposed to closely resemble the so-called "queen truffles" of Europe. A few resemble closely the white European species. Many are very small and a few attain to some size. Many are of no economic value, while some are large enough and abundant enough to be used for food. Some have a fine nutty flavor, others are apt to be a bit disagreeable. A small black *Tuber* has been found differing widely from any previous species found here and which developed a very strong odor. This last species was found in a spot in which I have collected different specimens every year for the last five seasons. Differing from all other previously collected forms, it turns alcohol to a deep purple color.

The methods of collecting the Tuberales and the Hymenogastrales are the same. The two groups are found frequently grow-

ing intermingled and sometimes are difficult of determination. The latter group forms a most important portion of the hypogaei. They are often large fructifications and are frequently produced in large numbers, and, above all, are strongly aromatic. These aromatic species provide a large amount of food for the rodents, the woodrats (*Neotoma*) being especially active in the search for them and leaving many signs of their work. The study of these signs is of value to the truffle hunter.

Many of the Tuberales appear to be without a conspicuous mycelium, but the Hymenogastrales are usually associated with an abundant white mycelial growth. The exposure of this mycelium will often quickly lead to the desired plants. One or two species of the Hymenogastrales are affected by parasites which leave masses of golden spores under the leaves. The presence of these spores serves as a guide to other species which are frequently associated with the host plants. Excavations made by the rodents for the different species, together with the many fragments left among the leaves, serve as an additional guide. Sometimes on warm, quiet days certain odors may be traced directly to certain species. In the end, however, instinct and experience in selecting favorable locations serve to secure the many different species, and then very often the plants appear in unexpected places where experience shows they should not appear.

Adjacent to San Jose there are ideally wooded hills of mixed oaks both in dense forest and in open scattered groups, and in other places not too far away there are fine forests of conifers and other trees which give the greatest variety of country and timber to work over. This district has been the scene of operations for the last six years. And even when one knows the ground thoroughly it is surprising how little of it may be covered on a day of good collecting. Frequently two or three hours will be spent in working over the ground under a single large oak, and on several occasions an entire afternoon has been spent in one place. The collector may pass rapidly from one place to another, as experience shows the ground to be barren, but though a place is barren one day, it may within a week or so be producing an abundance of fungi.

At Guadaloupe Mines there is a spot where the ground is moist yet warm, beneath a cluster of live oaks, which every season may be depended upon to supply numerous species over a long season. As an illustration of succession of fungi that may be found and the necessity for a constant going over the same ground, my collections for this season will be of value. In November, *Hysterangium* species; January, *Gautieria* species; February, *Genea* species; March, *Tuber* species, and April, *Tuber* species and *Hydnobolites* species. All these were more or less abundant and occurred within an area of less than one hundred square feet. In other seasons this same spot has yielded many other species. In another location where intensive search was made two seasons ago with success the same ground was recently gone over with great care and tubers collected that are probably the most important yet found in the United States. At Saratoga under a single tree that produced a number of species two seasons ago there was collected in February of this year on a single day nine genera and fourteen species.

The equipment of the truffle hunter is important. I use a wheel on many trips, as the roads are excellent and the stops are very frequent in some places. It is easily hidden in the brush when I leave the roadways and take to the high hills, and it makes accessible places otherwise out of one's reach. To the wheel is strapped a small combination rake and hoe with a four-foot handle. This implement is very useful in climbing, raking and digging and furnishes good protection in a snake country, as I well know. A short-handled hoe useful for work in thick brush, a trowel, knife, tweezers, lens, kodak, plenty of newspapers and a large number of small pasteboard cartridge boxes obtained at a shooting gallery. These small boxes are very useful in handling the many small specimens or single individual specimens, while large collections are wrapped in the paper. Lunch and thermos bottle complete the outfit, and all are packed compactly in the large canvas bags used by newsboys. These bags ride comfortably with a large load evenly distributed over the shoulders.

In the earlier parts of the season the edges of the forests and the small groups of trees are usually the best places for operations, although frequently the dense forest will yield good specimens.

Late in the season the best places are to be found deep in the forest, where the ground retains more moisture. When the collector finds a favorable place for operations the rake comes into use and a small area is raked free of leaves and humus. Watch must be kept in the leaves for certain species of *Hymenogaster* and of *Melanogaster* are to be expected and occur frequently. These are dark-colored species and are easily missed. Other species will appear entirely exposed on the surface of the earth and some will be just beneath the surface and out of sight. Excavation may be continued to a depth of a foot, at which depth most species will cease to be found. Care should be taken at all stages, especially near the surface, to avoid injury to specimens, but they will often be injured in spite of it, and many of the dark-colored species will require very careful search and sifting of the soil. The rewards are more often blistered hands and an aching back than truffles, but there are also some intensely exciting moments.

Any account of the underground fungi of the state of California must of necessity be very incomplete, as a large number of the species have not as yet been determined. The large collections already listed are being continually added to with additional species and variations of the older ones. The variations alone are adding many difficulties to the work of final determination. One benefit has accrued in the many collections, and that is the large number of immature specimens which will provide valuable material for life history studies. Where there has heretofore been a very definite lack of such material, it has seemed at times more readily secured than the mature forms.

Genea compacta Hk. originally collected in Marin County, California. Rare. Ascocarps minute, 5–7 mm., reddish brown, globose with oval opening at apex protected by mass of long intermingled dark-colored hairs which arise in clusters and spread fanlike from a series of pyramidal projections arranged at regular intervals around the edge of the apical openings. Minutely and sharply verrucose. Mycelial attachment inconspicuous. Found singly and in large numbers in the vicinity of Alma, spring of 1919. In clay at a depth of over six inches and in light soil among

rocks in thick madrone forest at a depth of two inches. Not easily detected, owing to the color, which resembles the dead dry madrone leaves. Harkness describes the plant as minute, up to one centimeter. Dr. Gilkey describes it as 7–10 cm., which is, I think, an error in printing. Very few tubers reach this size. It is noticeable that the hairs protecting the apical opening to the simple cavity disappear as the plant matures and the opening is enlarged. The same arrangement is seen in another *Genea* recently collected.

Genea arenaria Hk. described from a single collection made by Harkness. Collected subsequently by Prof. Gardner in the vicinity of Berkeley and appearing occasionally among other species in the collections made in the Santa Cruz Mountains. Not abundant, but widely scattered. Habitat favored is the moist clay soil well under large live oaks, plants appearing singly and among other species on the surface of the soil, but well covered with leaves. Ascocarps light brown, very irregularly folded, sharply verrucose; cavities are very complex owing to the folding of the tissue. Plants attain a size of 2–3 cm. in favorable seasons. Very difficult to see in the ground, as the color often blends with the debris on the surface where it appears. Care is necessary in collecting to avoid damage to specimens growing close to the surface of the soil. A faint brown mycelium is evident around the base of the plant, but is very much localized.

Genea Harknessii is widely distributed and very common early in the season. Ascocarps small, black and more or less simple and globose to occasional specimens very complexly folded. Sharply verrucose to the touch, appearing in groups on the surface of the soil well under leaves, under all kinds of shrubs, abundant in old trails and roads overgrown with *Baccharis* sp. Plants are often missed or damaged unless care is taken to avoid the soil surface with the excavating implement. It has been found here on the surface of the ground without leafy covering, on the edge of a hard-beaten road under madrones. Also found in leafy humus under *Arctostaphylos* sp.

This species has a very distinguishing feature in its earlier stages in the presence of a white floccose mycelial covering, enveloping the entire plant, and with hyphal threads penetrating the chambers.

It is not to be seen in old specimens and very quickly disappears after the plants are taken from the ground. Whether this is a parasite is yet to be determined, but the mycelium of the species is scant and dark colored. I find, however, nearly all plants have this covering, while it is not to be seen in other species so far collected.

Genea Gardnerii appears rarely among the specimens of *G. Harknessii,* but usually somewhat later in the season. It is so close in resemblance to the former species that it is difficult to determine offhand. It is black, verrucose and more complexly folded. It appears on the surface of the ground, but well covered with leaves and in places similar to the preceding form.

Genea cerebriformis is collected over wide areas throughout a very long season. It appears in all kinds of soil, but more abundantly in clay soil under oaks. Over one hundred have been collected in the month of January in wet clay soil and in the same ground again in April. Plants are minute, usually under one centimeter, but some of nearly 2.5 cm. have been recently found. The plants are white, rarely simple and globose, but more often a formless mass of complex chambers. Usually found below the surface to a depth of one to three inches, but are rather conspicuous in spite of the very small size. Recent specimens were found to have a very strong odor and to depart radically in size from the description.

Hydnotrya ellipsospora is described from a single collection made in 1909 at Pacific Grove by Prof. N. L. Gardner. It was again reported in March, 1917, when several plants appeared in collections made here. From these the original descriptions were verified. The type of this species is very small, but subsequent collections over four seasons have proven that the type is not representative of the size of the species. It appears in all localities under numerous trees and in various ways. The fresh plants are a very delicate purple color with a delicate "peach bloom" on the surface. This color very rapidly fades and in two or three days is gone, the plants becoming a dull brown. It is frequently found in soft, moist earth at a depth of several inches, but the plants are small. They are often very complexly folded, with very large

empty cavities. The flesh is very much like certain forms of *Peziza.* At Alma under pines there were collected a dozen plants in the month of March in very wet ground. These plants were all partly exposed at the surface of the ground and without any leafy covering. The plants in this collection were all over five centimeters in size and one measured nine centimeters in its largest diameter. At Saratoga the species was found under a great depth of humus and again proved to be of very large size, 7 cm.; and still later in the season it was found at Guadaloupe Mines in open rocky ground under oaks. While numerous smaller plants fully matured have been found, these large plants seem to be very common, in so far as this rather rare species may be called common. I think, from my experience, that the plant is widely distributed and abundant in moist years and is rare only for lack of those to collect it. This is large enough and abundant enough to be of value for food purposes, although it is not aromatic.

Tuber californicum is widely distributed and in some seasons very abundant, especially under oaks in moist clay soil. It is to be found on the surface of the soil or just below the surface. Many specimens are to be had by raking over the leaves of solitary oaks or on the edges of oak forests. Frequently the species attains a size of four or five centimeters, which is rather larger than described. It is white and very conspicuous, globose or roughly lobed, frequently irregular in shape and is sometimes deeply cracked in developing. The gleba is at first white, but later appears to be brown. This effect is seen as the spores arrive at maturity, when it appears to be filled with tiny grains of pepper. Its maturity is detected without the aid of a lens. Although this species is edible, it is a trifle astringent to the taste. Aside from this it has no particular flavor. One of the difficulties in collecting this plant for food is the fact that small slugs attack it in its early stages and riddle the gleba, leaving in the end only the peridium as an empty shell. Nematodes and larvae of a tiny black fly also infest the plants once they are opened by the slugs. At Alma I have found dozens of the small immature plants in very wet soil early in the season, but later, when they should have reached maturity, not one plant could be seen. Spore dispersal is secured by means of the slugs.

Tuber candidum is the most commonly collected and widely distributed truffle in this State. It is particularly abundant in some seasons in wet clay soil at the Guadaloupe Mines, generally under the live oaks, but frequently under other trees. It appears late in the winter and continues into the late spring or early summer. April and May seem to produce the greatest amount of mature plants. In places where it is collected in abundance one year it seems to be three or four seasons before it occurs in any large amounts again. The ascocarps are very smooth, pale brown or with a slightly pinkish color, or sometimes, when young, of a dark gray. It is variable as to color and shape. Generally globose or with two or three large lobes, it is sometimes found with deep furrows traversing the surface; occasionally it is cracked to a depth of several millimeters. The peridium is thick, the gleba is at first white, turning to a pale purple color and finally a rich brown, with a tinge of yellow as it reaches maturity, and the yellow spores fill the tissue. The asci may be seen for a long time during the development of the ascocarp, but the spores are slow to mature. In the middle of March I examined a certain piece of ground and found it barren. Two weeks later I collected a pint of mature specimens in it, and repeated two weeks later with some very large specimens. At the next visit, two weeks later, nothing was to be seen but a few empty peridia left by the slugs.

Plants are rarely on the surface of the soil, but are just beneath and down to a depth of several inches, and are easily raked up, but care must be used to avoid damaging them or missing them altogether if they are not abundant. Usually they are rather conspicuous if reddish brown, but if very pale or dull gray they are hard to find. Frequently single plants appear over wide areas, but generally they are in considerable numbers in a small area. They frequently are found in clusters of three or four plants, appearing to arise directly from the spores without any great mycelial growth.

The mycelial growth seems to be very scant and the plants show no basal point of attachment. Many specimens show where loose, fine hyphae traverse the surface of the ascocarp, but these disappear when the plants are removed from the ground. The dis-

persion of the spore is secured by the slugs that infest the plants and also by the rodents that sometimes use them for food. The plants have no odor, but are rather nutty of flavor and are abundant enough to be useful for food. Specimens this year have measured over three centimeters, which is larger than described for the species.

It has been found abundantly in one vineyard near the Guadaloupe Mines, and at Alma I found some fine large plants among the grass roots in a pasture adjacent to live oaks.

Tuber lignarium, or what has passed for that species, as collected in this district is perhaps the most interesting form so far collected. Described originally as *Terfeziopsis lignaria* by Dr. Harkness, the collector, it has been recently placed in the genus *Tuber* by Dr. Gilkey on a very careful study of the original collection. In its general appearance it is very close to *T. candidum*. The plants found here differ somewhat from the description of the type, although they have the typical spores with the recurved spines. During the past season it has proven more abundant than *T. candidum* and is to be found over a wide area and over a long season.

Considering its previous appearance in but one collection its occurrence here is of exceptional interest. In the spring of 1917 a small dark brown tuber, always immature, appeared in collections made all through this district. Plants occurred in all kinds of ground and under many trees, but generally in association with the oaks. Plants are uniformly a dark brown with areas of a lighter color where the venae externae open to the surface. The plants appeared in abundance on the warm upper slopes of the hills, where the growth is more open and the soil moist and light. Plants are found close to the surface, but usually down to a depth of three or four inches.

A long drought occurred and tubers of all kinds were very scarce until the winter of 1918–19. This drought was broken by a prolonged storm early in September of 1918. Over twelve inches of rain fell in three days at the Guadaloupe Mines. Following this rain there came a warm, humid spell lasting over a month, which was ideal for the growth of fungi. On the

27th of September, in an old road well covered with leaves, I collected about a dozen small brown tubers fully matured and growing closely together on the surface of the ground. These were typical specimens of *Tuber lignarium* on the appearance of the spores. The same conditions repeated to some extent in November, 1920, and mature tubers were again collected in the same place. These tubers had fully matured since the rains ceased on the 12th of the month.

In February of the present year the same brown tubers began to appear under the oaks, and in March they were to be found everywhere on the warm upper hillsides, and in April they reached the greatest abundance and maturity. Many of these plants reached a size well over 2 cm. They are very rough in appearance, generally globose or very much lobed, occasionally flattened with the venae externae converging at the apex. The peridium appears to be rough without being verrucose; the tissue of the gleba is at first white, then becoming a faint purple, and finally brown as the mature spores appear all through the tissue. It is very much like *T. candidum* in taste and is without odor. There is very little sign of any mycelium and no point of attachment visible. Plants examined in the ground show only a few fine threads traversing the surface of the plant. Frequent clusters of four plants are found together, apparently arising from spores in the same ascus. In cases like this there is a development of one plant at the expense of the others, it seemingly absorbing its food from the surrounding moist ground, so that one will hardly grow at all, the next but little, the third less than average, while the one may be considerably above the average.

Geopora Harknessii occurs regularly in the winter and early spring in some abundance usually under the pines all through the mountains. I have found it rarely under the oaks. Globose or irregular in shape, roughly folded tissue, with a very dark brown tomentose peridium and reaching a size of 4–5 centimeters if conditions are favorable. The plants are not easily seen under the wet leaves owing to the color. Frequently found on the surface of the ground, but well covered with the pine needles, but very often is to be collected in clay soil fully exposed at the surface.

Hydnotr[illegible] Setchellii is one of the rarest forms found. It was described from one of the Harkness collections and not reported again until found with other rare forms at Guadaloupe. The plants are small and of a clay color with a white gleba. Found in wet clay soil at a depth of three inches. Material collected here was sufficient to verify all details of the descriptions which were made from long-preserved material. There have been some additional collections and one that would indicate that the species attains a size of over three centimeters.

Delastria rosea has been collected twice, once in an earthy pocket among rock ledges under laurel and once this last season under pines. It is a small inconspicuous plant tinged with red and resembles very much one of the small rosy-colored Hymenogasters. It is, in spite of its color, a very rare and difficult plant to collect. The last collection was made in a bed of purple mycelium which was producing a large amount of a species of *Elaphomyces*. To be expected under all kinds of trees.

Hydnobolites californicus occurs in abundance apparently under all kinds of trees and begins to develop very early in the winter and remains up till the first of June. Very slow in maturing and quickly riddled by the slugs. It appears in a vein of coarse white mycelium, to which it is attached by a long, thick rhizomorph, which breaks away very easily. The point of the attachment is easily seen, however. It is a dirty white, compactly developed globose or irregular ascocarp without a thick protecting peridium as in the various species of *Tuber*. The venae externae open in numerous places to the surface and are very conspicuous in the young plants. It becomes dry and gristly in age, turning to a light brown color.

Several large plants collected late in the season possessed a very strong musty odor without being in any way decayed. These were found in a bed of mycelium about two inches below the surface of the soil under oaks. As the plants matured they pushed farther toward the surface and finally were severed from the mycelium altogether as they reached the surface of the soil, where they were covered very slightly with dry leaves.

Pseudobalsamia magnata occurs early in the season in wet clay

soil under oaks and pines, usually at a depth of one or two inches, in close association with a conspicuous mycelium, and usually with a large number of plants in close relation, although not seen in clusters. Although the plants are, as a rule, less than two centimeters in size, they are conspicuous in color and easily seen. Plants more or less globose or flattened at the apex where the venae externae converge. The peridium is sharply verrucose, somewhat variable in color, gleba white with large asci and spores easily identified. Some plants collected in May and June of this year appear to be this species, but were larger and of a very bright orange color.

A variety of this species, var. *nigra*, has been collected rarely and is little known. What has appeared to be this form appears scattered and solitary on the surface of the ground under laurels. A recent collection of what appeared to be this species, however, gives asci and spores of a very distinct nature and is probably a distinct species, although the general shape is typical of the species.

Pachyphloeus citrinius is not at all well known and the collections are all referred with some doubt. It has appeared twice during the last season in ground that has been searched for the last six years. Just under the surface of the soil under oaks and *Heteromeles* sp. The surface of the plant is covered with minute warts, is of a dark red color, with several folds near the base, a definite mycelial attachment. Plants are globose and with a very deep opening at the center of the apex where the venae externae converge. The tissue of these plants was blood red.

Elaphomyces variegatus is found at various points pretty well buried in the loose soil. It appears in a conspicuous bed of yellow mycelium and is at maturity a large yellow plant very conspicuous in appearance. It is found from January to June following the moisture zones down the hillsides in dense forests. It develops from two to ten inches deep in the soil and reaches a size of 3–4 centimeters, and is globose, roughly warted, with large cells filled with a colorless tissue making up the gleba. The asci dissolve at a very young stage. In maturity the gleba becomes a powdery dark mass of spores resembling a form of *Scleroderma*.

Endogone macrocarpa occurs in many places as isolated plants,

but occasionally a considerable number will be found several inches deep in the soil under an oak. The plants are dirty white or tinged with a faint rosy color at first, globose, 1–2 cm. in size, and when cut open have the appearance of being filled with grains of sand. In one place I have watched for three seasons for a recurrence of hypogaei under an oak where this form was found in considerable abundance in March, but nothing of any kind has been found that would throw light upon the future development of this species.

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THE HETEROECISM OF PUCCINIA MONTANENSIS, P. KOELERIAE, AND P. APOCRYPTA[1]

E. B. MAINS

(WITH TEXT FIGURES 1–4)

Puccinia montanensis Ellis, *P. Koeleriae* Arth., and *P. apocrypta* Ellis & Tracy belong to the group of grass rusts having long-covered telia to which *P. triticina* Erikss. and *P. secalina* Grove (*P. dispersa* Erikss.) belong. In connection with the investigation of the last-named rusts, which is being conducted by this laboratory in coöperation with the Office of Cereal Investigations of the U. S. Department of Agriculture, some attention has been given to a study of the related rusts of this group as a part of the general rust investigations of the laboratory, for the help which such a study will afford in the solution of cereal rust problems. In connection with this work considerable taxonomic study of the material in the Arthur herbarium has been necessary, which has resulted in a partial realignment of the rusts involved and has formed the basis for the treatment of these as finally published in the North American Flora.[2]

PUCCINIA MONTANENSIS

Of the three rusts *Puccinia montanensis* is perhaps the most distinctive. It was described by Ellis[3] from a collection upon *Elymus*

1 Contribution from the Botanical Department of the Purdue University Agricultural Experiment Station. This work is in part a result of the studies being conducted cooperatively between that Department and the Office of Cereal Investigation, Bureau of Plant Industry, U. S. Department of Agriculture.

Read before the Mycological Section of the Botanical Society of America at Chicago, Ill., on Dec. 29, 1920.

2 Arthur, J. C., & Fromme, F. D. Dicaeoma on Poaceae. North American Flora 7: 325, 330 and 332. 1920.

3 Ellis, J. B. Descriptions of Some New Species of Fungi. Journ. Mycol. 1: 274. 1893.

condensatus made by Rev. F. D. Kelsey at Helena, Montana, July, 1891. An examination of the type (Ellis & Ev., N. Am. Fungi 2892) shows that this rust is to be distinguished from the other grass rusts having long-covered telia by the arrangement of the uredinia and telia in lines, by the broad teliospores and the abundant thin-walled paraphyses bordering the uredinia (fig. 1). In

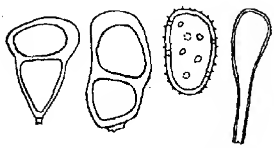

FIG. 1. Teliospores, urediniospore and uredinial paraphysis from the type specimen of *P. montanensis* (x 400).

1915 Arthur[4] sowed aeciospores from *Hydrophyllum capitatum*, obtaining uredinia and telia upon *Agropyron tenerum* and uredinia upon *Elymus virginicus*. This material was determined as *Puccinia montanensis*, and on this basis the Hydrophyllaceous and Boraginaceous aecia of the United States have been considered as belonging to this species.

AECIAL RELATIONSHIP OF PUCCINIA MONTANENSIS

In the spring of 1919 two collections of *Puccinia montanensis*, one upon *Elymus canadensis* and the other upon *Agropyron* sp., made by H. S. Jackson at Boulder, Colo., Nov. 12, 1918, were found to be viable. On the assumption that they should produce aecia upon Boraginaceous or Hydrophyllaceous species, these collections were sown on *Myosotis palustris*, *Phacelia Purshii*, *Nyctelea Nyctelea*, and *Hydrophyllum* sp. without obtaining infection. Later in the same summer Mr. E. Bethel sent collections of a rust on *Agropyron tenerum*, *Agropyron Smithii* and *Hordeum jubatum* which he had collected with Dr. G. H. Coons at Mancos, Colo. Accompanying this material was a collection of aecia on *Berberis Fendleri*, which he stated was so closely associated with the grass rust as to suggest relationship. Such an association did not neces-

[4] Arthur, J. C. Cultures of Uredineae in 1915. Mycologia 8: 137–139. 1915.

sarily mean a connection between the two forms, as the grass rust may have come from aecia upon a plant which had died down and disappeared earlier in the season. Mr. Bethel remarked that the situation was made the more difficult to explain by the absence of *Koeleria cristata*, the grass host supposedly connected with the *Berberis* aecia. On this account, and because of the insistence of Dr. Coons that there must be some connection between the aecia upon *Berberis Fendleri* and the associated grass rust, he sent the material for culture and study. An examination of the material showed that the rust on *Berberis Fendleri* was *Aecidium Fendleri* Tracy & Earle, and that on the grasses was *Puccinia montanensis*. As such a connection would add an entirely new aecial host in a genus rather far removed from *Hydrophyllum*, it became important to establish or disprove this by cultures. The aeciospores, proving viable, were sown and produced infection upon *Hordeum jubatum* and *Hystrix Hystrix*. In the meantime Mr. Bethel made a sowing in his garden at Denver, Colo., from a part of the same collection of aecia and obtained infection upon *Agropyron tenerum*. Mr. Bethel was kind enough to send some of this material to me for study.

Further evidence of this connection was obtained from cultures made in the spring of 1920. Four collections gave infection upon *Berberis Fendleri*. Of these, three were from Mancos, Colo., on *Agropyron tenerum*, *A. Smithii* and *Agropyron* sp., rusted grasses associated with the *Berberis Fendleri* used in the aecial culture mentioned above. The fourth culture was from telia obtained by Mr. Bethel at Denver by sowing the above aecial material on *Agropyron tenerum*. Ten other collections, eight from Colorado and two from Indiana, were sown on *Berberis Fendleri* without infection. In most of these cases the teliospores germinated weakly, and this may account, in part at least, for the negative results.

A careful comparison was made of the material obtained from the above cultures with the type of *P. montanensis*. It was found that all the material, shown by these cultures to be connected with aecia on *Berberis Fendleri*, agreed closely with the type of *P. montanensis*. The uredinia are cinnamon-brown and are provided

with an abundance of thin-walled, peripheral paraphyses (fig. 2), giving the sori a fringed appearance under the binocular. The

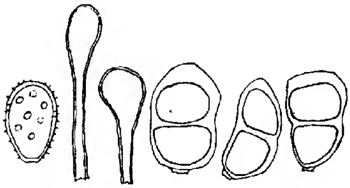

FIG. 2. Urediniospore, uredinial paraphyses and teliospores of *P. montanensis* obtained from culture of *Aecidium Fendleri* on *Hystrix Hystrix* (× 400).

urediniospores are 19-26 by 21-34 μ and have brown walls and 8-10 scattered germ pores. The teliospores are broad, 18-34 by 35-64 μ (fig. 2), and have rather thick walls.

On the other hand, a comparison of the above material with that resulting from the cultures with *Hydrophyllum* aecia mentioned above (Arthur l. c. 4) showed points of marked difference. The uredinia and telia connected with the *Hydrophyllum* aecia are scattered or loosely grouped. The uredinia are yellow and without paraphyses. The urediniospores are 13-21 by 19-25 μ and have pale yellow or colorless walls with 6-8 scattered germ pores. The teliospores are narrow, 13-23 by 32-48 μ, with thin walls except for the apical thickening (fig. 3). On the basis of the above cul-

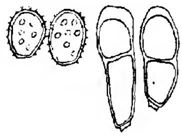

FIG. 3. Urediniospores and teliospores of *P. apocrypta* on *Elymus virginicus* obtained by culture with aeciospores from *Hydrophyllum capitatum* (× 400).

tures, therefore, *Berberis Fendleri* must be considered as the only proven aecial host of this rust. That other aecial hosts exist is a possibility. The geographic distribution of *P. montanensis*, as indicated by specimens in the herbarium, is British Columbia, Wis-

consin, Indiana, southward to New Mexico and southern California, while *Berberis Fendleri* is limited in its distribution to the mountains of Colorado and New Mexico. Such a difference in distribution, however, would be explained if this rust is not dependent upon its aecial stage, but is able to overwinter in the uredinial stage. Mr. Bethel has made observations in Colorado which indicate that such an overwintering may occur there. It is probable, however, that part of the negative results obtained by culturing *P. montanensis* on *Berberis Fendleri* can be explained only by the presence of races in this rust going to different aecial hosts. From present information it is impossible to foretell what these hosts may be. They may be other species of *Berberis* or *Mahonia* or possibly species of some closely allied family. For the present the most that can be said is that *Puccinia montanensis*, in part at least, has *Berberis Fendleri* as its aecial host.

AECIA OF PUCCINIA MONTANENSIS

A study to determine the identity of the aecia on *Berberis Fendleri* obtained from the above-described cultures resulted in finding that they agree with the type of *Aecidium Fendleri* Tracy & Earle. This type also was collected at Mancos, Colo., and Mr. Bethel assures me it was collected at the same place where the material used in the above cultures was obtained. The culture material and the type agree in having aeciospores 18–23 by 20–30 μ. As aecia on *Berberis Fendleri* and the closely related *Mahonia Aquifolium* have been considered as belonging to *Puccinia Koeleriae* Arth., it became necessary to make a study of the latter rust in comparison with *P. montanensis*.

PUCCINIA KOELERIAE

Puccinia Koeleriae Arth.[5] (p. 247) was based on material resulting from cultures in which aecia were produced upon *Mahonia Aquifolium* (Pursh.) Nutt. from teliospores on *Koeleria cristata*. An examination of the type of this species which was collected by E. Bethel at Ouray, Colo., Aug. 23, 1907, shows that it has scat-

[5] Arthur, J. C. Cultures of Uredineae in 1908. Mycologia 1: 225–256. 1909.

tered uredinia and telia, uredinia with thick-walled (1.5–3 μ), peripheral paraphyses (fig. 4), and narrow teliospores, 15–21 by 45–55 μ. In these characters of the uredinia and telia, therefore, *Puccinia Koeleriae* shows a number of important differences from

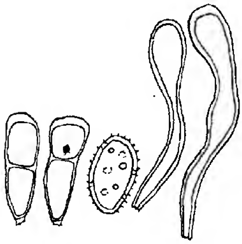

FIG. 4. Teliospores, urediniospore and uredinial paraphyses from the type specimen of *P. Koeleriae* (× 400).

P. montanensis and must be considered as a distinct species, while showing relationship in that both possess abundant paraphyses and urediniospores with brown, thick walls and 8–10 scattered pores.

PUCCINIA APOCRYPTA

A study was made of the rust used by Arthur (l. c. 4) in the cultures of the *Hydrophyllum* aecia mentioned above, in order to establish its identity. As the result of this study it was decided that the rust in question probably was *Puccinia apocrypta* Ellis & Tracy. This rust was described by Ellis & Tracy[6] from material collected by Tracy at Cañon City, Colo., Aug., 1887, on "*Asprella Hystrix*," which host determination Arthur[7] (p. 138) has shown probably was an error for *Sitanion elymoides*. An examination of this material shows that *Puccinia apocrypta* is very distinct from both *P. montanensis* and *P. Koeleriae*, being distinguished by its smaller, paler urediniospores having fewer germ pores and by the absence of paraphyses in the uredinium. Still further cultural evidence of the aecial relationship of this rust was obtained when, in June,

[6] Ellis, J. B., and Tracy, S. M. A Few New Fungi. Journ. Mycol. 6: 76–77. 1890.

[7] Arthur, J. C. Cultures of Uredineae in 1915. Mycologia 8: 125–141. 1916.

1919, Mr. G. R. Hoerner sent a collection of aecia on *Hydrophyllum* obtained at Corvallis, Oregon. Aeciospores from this collection were sown, obtaining infection upon *Elymus virginicus*, with a slight development on *Elymus canadensis* and *Triticum aestivum*, both of the latter, however, proving not to be congenial hosts. A study of the *Elymus virginicus* material showed that it agreed with the other material of *P. apocrypta*.

DISCUSSION

The foregoing work, while by no means settling the complete aecial relationships of these rusts, has resulted in a realignment of them, which, it is felt, is more in keeping with their morphology. *Puccinia montanensis*, so long as it was considered as having its aecia on *Hydrophyllum*, invited comparison with such species as *Puccinia bromina* Erikss. on *Bromus* and *P. secalina* Grove (*P. dispersa*) on rye, both of which have their aecia on the closely allied family, Boraginaceae. From both of these species *P. montanensis* is distinguished, among other characters, by possessing abundant paraphyses in the uredinium, these being practically lacking in both *P. bromina* and *P. secalina*. *Puccinia montanensis* with aecia on *Berberis*, however, invites comparison with other species of rust with long-covered telia having aecia on species of the Berberidaceae. Such species are *Puccinia Koeleriae* in North America with aecia on *Mahonia Aquifolium* and *Puccinia Arrhenatheri* in Europe with aecia on *Berberis vulgaris*. Both the latter rusts agree with *Puccinia montanensis* in possessing abundant paraphyses in the uredinium. In *Puccinia apocrypta*, on the other hand, having *Hydrophyllum* for its aecial host, we have a rust which with its lack of paraphyses, at least, agrees with *P. bromina* and *P. secalina*. It is true that *P. apocrypta* differs from both of the latter in its smaller urediniospores with lighter colored walls, but similar differences can be found in the grass rusts among those having species of Ranunculaceae for their aecial hosts.

It is difficult, of course, to say what other species may serve as aecial hosts for the above rusts besides those shown by culture. It would appear that *Puccinia montanensis* consists of several races, one of which goes to *Berberis Fendleri*. It is not possible at the

present time to say what the aecial hosts of the other race or races may be, but they are likely to be some other species of the Berberidaceae or some closely allied family. *Puccinia apocrypta* presents a somewhat similar situation. As this rust, however, has been cultured only by sowing aeciospores from *Hydrophyllum* on grass hosts, no cultures having been successfully made by sowing teliospores upon a series of Hydrophyllaceous and Boraginaceous species, the aecial host range for this species can not be given with certainty. It is probable, however, that besides *Hydrophyllum capitatum*, which has been shown by culture to be an aecial host, other species of *Hydrophyllum* and species of *Phacelia* and *Nyctelea* will be found to belong here, possibly connected with different races. Whether the Boraginaceous aecia of this country also belong here can only be settled definitely by cultures. It seems probable, however, that a part of these aecia will be found to be connected with rusts identical with or very similar to *Puccinia bromina* and *Puccinia secalina*, and presumably will be found to have their connections with *Bromus* and *Agropyron* rusts. *Puccinia Koeleriae* offers but little information as to its host range, as its aecial connection is founded on only one culture to *Mahonia Aquifolium*, and it is likely that other Berberidaceous species will be found to serve as hosts. A thorough understanding of these species can be reached only through the gradual accumulation of field evidence of associations such as those obtained by Mr. Bethel and Dr. Coons and by cultures to determine both grass and aecial hosts of such rusts. The presence or absence of races and their limitations within the species and the limitations and relations of the species to each other can be determined only by such methods.

To Prof. H. S. Jackson the writer is indebted for helpful suggestions from his knowledge of western rusts. Dr. J. C. Arthur especially has given many helpful suggestions, drawn from his large acquaintanceship and work with this group. The writer also is indebted to Mr. E. Bethel and Dr. G. H. Coons for their discriminating field observations and for material.

DEPARTMENT OF BOTANY,
AGRICULTURAL EXPERIMENT STATION,
LAFAYETTE, INDIANA.

NEW JAPANESE FUNGI

NOTES AND TRANSLATIONS—X

TYÔZABURÔ TANAKA

HYPODERMOPSIS THEAE K. Hara sp. nov. in Chagyôkai (Tea Journal) 14^7: 13–14. T. 8, vii, July, 1919. (Japanese.)

Caulicolous, spots orbicular or irregular, large, light reddish-brown; perithecia superficial, scattered or gregarious, flat, orbicular, elliptical or oblong, simply elongated or slightly curved, black or lacquer-black, later lacerate from the middle giving a somewhat hoary appearance, usually veiled with epidermal tissue of the host. 400–700 μ broad, 130–150 μ high, length irregular, wall black, parenchymatous, 40–50 μ thick; asci clavate, oblong-ovoid or short-cylindrical, rounded at the apex, pedicellate at the base, 50–66 x 20–23 μ, paraphysate, octosporous; paraphyses filiform, not forked, equal to or slightly longer than the asci, 1–1.5 μ across; ascospores oblong-ovoid, oblong or pyriform, both ends rounded, multinucleate, 4–6-septate, hyaline, 18–23 x 6–7.5 μ.

Parasitic on the trunks and branches of *Thea sinensis.*

Type localities: Shidzuoka-ken Hamana-gun Hikuma-mura, Nov. 12, 1918 (K. Hara); Shidzuoka-ken Abe-gun Chiyoda-mura, Dec. 6, 1918. (K. Hara.)

Spots occur on the woody part of the tea-plant as light reddish-brown, round or irregular patches at least 5 cm. in diameter. Such spots increase their size in various directions, often running together in large irregular patches entirely surrounding the branches. Black perithecial bodies appear on the diseased spots as scattered or crowded minute dots of 0.5 mm. to 1.0 mm. across. The infected branches die out in a short time.

The Japanese name of the disease: Chaju no Kasshoku Azabyô. (Brown spot of the tea-plant.)

Illustrations: One half-tone plate showing the diseased spot, cross-section of a perithecium, asci (with a paraphysis) and ascospores. (Figs. 1, 5, 6 and 8.)

STAGNOSPORA THEAE K. Hara sp. nov. in Chagyôkai (Tea Journal) 14^7: 14–15. T. 8, vii, July, 1919. (Japanese.)

Pycnidia scattered, globose or depressed-globose, 100–150 μ in diam., wall parenchymatous, composed of dark brown polygonal cells 4–8 μ in diam.; ostiola even or warty, opening round, 15–20 μ across; pycnospores elongate-cylindrical or sub-clavate, both ends rounded, 6–11-septate, hyaline, 18–35 x 4–5 μ; pedicels of pycnospores short, arising from the base of pycnidial chamber, 4–6 x 2–2.5 μ.

Saprophytic on the trunks of *Thea sinensis*.

Type locality: Shidzuoka-ken Iwara-gun Ejiri-chô, Nov. 24, 1918. (K. Hara.)

Illustrations: One half-tone plate showing diseased spots, section of a pycnidium, pycnospores and pedicels (Figs. 13–16).

LEPTOSPHAERIA HOTTAI K. Hara sp. nov. in Chagyôkai (Tea Journal) 14^9: 14–15. T. 8, ix, Sept., 1919. (Japanese.)

Leptosphaeria Hottai K. Hara nom. subnud. in Byôchû-gai Zasshi (Journal Plant Prot.) 6^1: 37. T. 8, iv, April, 1918. (Japanese.)

Spots orbicular or irregular, large, brown, with greasy luster, later darker with minutely crowded dots of perithecia; perithecia superficial, nearly always covered by epidermis, globose or depressed-globose, 350–500 μ in diameter, wall carbonaceous, black, thick, especially so at the place touching the host epidermis so as to show more or less clipeus-form, ostiolate at the apex; opening of ostiola round, 30–45 μ across; asci clavate or cylindric, apex round, base short pedicellate, 60–70 x 8–10 μ, paraphysate, octosporous; paraphyses filiform, considerably longer than the asci, usually simple, hyaline, 1–1.5 μ across; ascospores biseriate or obliquely tri-seriate, ellipsoid, oblong-ovoid or fusoid, at first unicellular and 4-nucleate, later 3-septate with one-sided middle septum, constricted, flavescent, 12–18 x 4.5–5.5 μ.

Parasitic on the trunks of *Thea sinensis*.

Type localities: Ejiri, Hikuma, Mitsuke and Takabe in Shidzuoka Prefecture.

The shape and size of the ascospores resemble *Leptosphaeria Coniothyrium* forma *Theae*, but the shape of the perithecia differ greatly from this species, so a different name is given.

Japanese name: Kuroazabyô (black spot disease).

This disease was at first discovered by Masazò Hotta at Aratama district, Inasa-gun, Shidzuoka-ken, and reported in the Annual Report of Shidzuoka-ken Agricultural Experiment Station (for the fiscal year T. 5, 1916). Hara in the Byôchû-gai Zasshi states that the disease is serious in the vicinity of Hamamatsu and also occurs in the Mie Prefecture.

Illustration: One half-tone text figure showing asci, paraphyses and ascospores. (Fig. 6.)

SILLIA THEAE K. Hara sp. nov. in Chagyôkai (Tea Journal) '14[9]: 15–16. T. 8, ix, Sept., 1919. (Japanese.)

Stromata scattered or gregarious, at first immersed, later erumpent, pillow-shaped or wart-like, sometimes confluent, afterwards with rounded margin adhering to substratum, 0.8–5 mm. in diam., surface orange-yellow or dirty-yellow, rugose with black perithecial spots, inside orange-yellow, somewhat membranaceous in structure, with imbedded perithecia; perithecia globose or ovoid, dark-colored, 300–350 x 180–300 μ, wall carbonaceous or parenchymatous, dark-colored; ostiola terminal, forming wart-like protrusions on the surface of stroma, opening one, round, 80–100 μ across; asci cylindrical or clavate, apex rounded or somewhat mamelon-shaped, base tapering to pedicel, 150–170 x 20–25 μ, paraphysate, octosporous; paraphyses filiform, forked, longer than or equal to the asci, 1–1.5 μ across; ascospores biseriate or irregularly tri-seriate, fusoid, cylindrical or clavate, rounded at both ends, straight, bent or curved, or more or less lunate, with numerous biseriate oil globules, giving the appearance of a septum, 6–11-septate, constricted or straight, hyaline, 35–44 x 8–9 μ, germinating at both ends.

Parasitic on trunks and branches of *Thea sinensis*.

Type locality: Shidzuoka-ken Hamana-gun Hikuma-mura, November 11, 1918. (K. Hara.)

The affected area first appears on one side of branches or trunks as a spot of dark pink or gray color, and by increasing its size it entirely surrounds the bark, simultaneously spreading upwards and downwards. The stroma then makes its appearance as dirty-yellow or in some rare instances pinkish-yellow spots, raised from the diseased surface like warts or a pillow-shaped elevation or sometimes a button-shaped swelling of 0.8–8 mm. in diameter. Perithecial bodies are formed on the stromata as elevated or flat

black spots round in shape. Such spots are solitary or run together to form warts of irregular outline. The dying out of the diseased portion is rather slow, occurring two or three years after the infection. The surrounding area of stromata often develops a greenish color which looks attractive in comparison with pink stromatic bodies.

Suggestions for control: (1) Diseased branches should be removed and destroyed by fire; (2) infected areas on trunks should be peeled off and disinfected with grafting wax or a similar substance; (3) to prevent the disease the woody part of the tree should be washed with Bordeaux mixture.

Japanese name of the disease: Chaju no Samehada-byo (Sharkskin disease of the tea-plant).

Illustration (Fig. 7, on p. 16): One half-tone text figure showing asci, paraphyses and ascospores (one germinating).

ASCOCHYTA THEAE K. Hara sp. nov. in Chagyôkai (Tea Journal) 14^{10}: 13–14. T. 8, x, October, 1919. (Japanese.)

Pycnidia punctiform, globose or depressed-globose, 80–120 μ, wall membranaceous, consisting of dark-brown carbonaceous polygonal cells 5–10 μ in diam.; ostiola apical, even or papillate, opening simple, 10–12 μ across; pycnospores ellipsoid, cylindric or subovoid, both ends rounded or truncate, uniseptate, dividing into homogenous or slightly unequal locules, provided with a large oil globule in each locule, not constricted at the septum, hyaline, $7–10 \times 3.5–4.5\ \mu$.

Parasitic on the leaves of *Thea sinensis*.

Type locality: Shidzuoka-ken Abe-gun Okawa-mura, October 24, 1918. (K. Hara.)

Found occurring on tea leaves infected by *Exobasidium reticulatum*.

Illustration: One half-tone text figure showing pycnospores. (Fig. 8, on p. 14.)

VALSA THEAE K. Hara sp. nov. in Chagyôkai (Tea Journal) 14^{11}: 15–16. T. 8, xi, November, 1919. (Japanese.)

Stromata scattered, at first immersed, later erumpent, black, punctiform to the naked eye, conical, apex projecting, black, typically Valsa-like; perithecia annular, 5–10 or more on one stroma,

globose or depressed-globose, 200–350 μ broad, 130–170 μ high, wall fungoid-parenchymatous, black, 12–15 μ in thickness; ostiola separate but grouped, elongate, 30–300 μ long; asci clavate or cylindrical, rounded at the apex, narrowed into pedicel at the base, 25–30 x 4–5 μ, aparaphysate, octosporous; ascospores distichous or irregularly distichous, cylindrical, rounded or truncate at both ends, usually curved in one direction, rarely straight, hyaline or flavescent, 5–10 x 1.5–2 μ.

Parasitic on weakened trunk of *Thea sinensis*.

Type locality: Shidzuoka-ken Hamana-gun Hikuma-mura, December 12, 1918. (K. Hara.)

Illustration: One half-tone text figure showing cross-section of a stroma with perithecia, asci and ascospores. (Fig. 9.)

Notes: There are two species of Valsa found on the tea-plant, but it is still undetermined which causes the die-back of the trunk. The other species not described here has no stroma, though it resembles this species in other respects. The latter is left unnamed until its characters are more fully studied.

DIATRYPE THEAE K. Hara sp. nov. in Chagyôkai (Tea Journal) 14[11]: 19. T. 8, xi, November, 1919. (Japanese.)

Stromata subepidermal, later erumpent, oblong or linear, 1–2 mm. long, 0.5–1 mm. wide, cross-section oblate-urceolate, slightly rounded at the upper part, flat or somewhat concave at the base, with a broad neck at the top, cinereous, more or less parenchymatous; perithecia deeply immersed in the stroma, globose or ovoid, 300–330 μ high, 100–170 μ in diam., wall parenchymatous, dark colored, 15–30 μ thick, long ostiolate; ostiola penetrating the stromatic neck, opening round, 20–25 μ across; asci clavate or obovoid, apex usually narrowed, rarely swollen and rounded, base tapering very much into a filiform pedicel, 20–40 x 6–8 μ, aparaphysate, octosporous; ascospores cylindrical or fusoid, rounded at both ends, straight or curved, plane or nucleate at both ends, hyaline or flavescent, 7–11 x 2–2.5 μ.

Saprophytic on the trunks of *Thea sinensis*.

Type locality: Shidzuoka-ken Abe-gun Ókawa-mura, October 24, 1918. (K. Hara.)

Differs from *Diatrype stigma* (Hoffm.) Fr. in the shape of the stromata, also from *D. Hochelagae* E. & E. in the aparaphysate asci. The former is found in the same village where the present species was discovered.

Illustration: One half-tone text figure showing infected trunk, cross-section of a stroma, asci and ascospores (Fig. 12).

HENDERSONIA THEAE K. Hara sp. nov. Chagyôkai (Tea Journal) 14^{12}: 22–23. T. 8, December, 1919. (Japanese.)

Pycnidia globose or depressed-globose, 60–130 μ in diam., immersed, later slightly erumpent, pycnidial wall parenchymatous, composed of angular cells of 4–7 μ in diam., apically ostiolate; ostiola papillate or warty, with opening 11–15 μ across; pycnospores broad-ellipsoid or broad-fusoid, broadest near the middle, narrowed toward both ends, at first hyaline, finally changing to yellowish-brown, 3-septate, somewhat constricted, 7–10 x 4–5 μ.

Parasitic on the leaves of *Thea sinensis.*

Type locality: Shidzuoka-ken Abe-gun Okawa-mura, October 24, 1918. (K. Hara.)

Foliicolous, appearing mostly at the leaf tips, on spots that increase their area downward by degrees toward the leaf base with definite but undulating border lines. The infected area is at first dark brown, but later it changes color, becoming gray, and minute spottings of fungus bodies appear somewhat sparsely on the surface. The lower surface of the diseased area is light brown in color.

Illustration: One half-tone text figure showing an infected leaf, a section of a pycnidium and pycnospores. (Fig. 13, nos. 1, 2, 3.)

Since March, 1919, Kanesuke Hara has been publishing in Chagyôkai (Tea Journal) a series of papers dealing with the diseases of the tea-plant, in which he describes a number of new species of fungi. The translations given here and in the last number of New Japanese Fungi (Mycologia 12^6: 330–332) cover nearly all of those published in 1919; the rest of his new species will be given in the subsequent numbers of this series.

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WASHINGTON, D. C.

SOME OF THE WAYS OF THE SLIME-MOULD

Thomas H. Macbride

A recent volume by Professor D'Arcy W. Thompson, bearing the terse title "Growth and Form," seems to me for the mycologist very suggestive, and to that extent, at least, one of the most useful among the books of later years. A paragraph from its pages might form the text for the discussions of the present paper. After developing at length and very clearly the various problems of tension, particularly as determined by molecular attractions, in liquids mass-tensions, surface-tension and their interactions, the author applies to *Æthalium*, a common slime-mould, the same principles applicable to so much water, assuming the myxomycete to have the same specific gravity, and both liquids placed for experiment under similar conditions. The paragraph, too long for quoting here, is noteworthy for two reasons: in the first place it presents, as is believed, the first citation of a slime-mould anywhere or at any time in a court of physical research; and in the second place, it is the first attempt, so far as I have noted, to refer the phenomena especially characteristic of the organisms in question to forces purely physical in nature—*i.e.*, to such as are familiar to the laboratories of purely physical science.

In these days of refined and beautiful physical research chemical and physical reactions are so interrelated that only the most accomplished expert in either or both fields may venture their mention, not to say discussion. The present writer makes no pretension; but there are in the life history of the slime-moulds certain peculiar facts, patent to ordinary observation, always worthy of study and, as it would seem, deserving, for thorough apprehension, not to say comprehension, all the help that physical science may afford. Professor Thompson's argument is very helpful, and yet—as illustrating the way of the slime-mould—permit me to summon the chief offender.

In 1876 Sachs in the one-time classic Physiology, discussing

protoplasm, refers to *Æthalium* and goes on to say: "It may happen that the substance creeps up the stems of plants a metre high and moves in the form of thin threads becoming collected above on large leaves as thick cakes the size of the hand. . . . There remains no doubt whatever that we have here to do with a structure which resembles in every detail the circulating protoplasm in living plant cells, only its mass is relatively extraordinarily large."

What we have to account for is the continuous stream that carries on until apparently the source of supply is exhausted, and accumulates at considerable elevation masses to be weighed in ounces, say, half a pound. It matters not that ascent was made a meter high; a centimeter high would do just as well, as far as that goes. I have photographed the same thing, eight feet above its base of operations, seated in the crotch of a vigorous bur-oak tree.

It is an old story. Men have been watching the phenomenon for two hundred years. Linné saw the mucors, as he called them, but was less a student. The greater man by far, the greatest mycologist the world has known, devotes pages to our problem. Fries says in Systema Mycologicum: "Often have my eyes, not without peculiar pleasure, watched the transition from weak beginnings to the perfection of complete development. The celerity in most of them is marvellous. At one time (for safe carriage) I deposited the plasmodium of a *Diachæa* in my hat, and within the space of one hour it had covered the greater part of it with its elegant white net work."

It must not be supposed that the outer head of the great Swedish student, no matter how brilliant the brain it covered, left the inner surface of the hat any less free from what, for cytoplasm, printers might term "objectionable matter," than would be the case did the hat cover the best brushed and tended human capital to be found in Chicago, and yet I have no doubt whatever of the accuracy of the Friesian narrative.

Permit me to cite a more recent observation: On the shore of an Iowa lake, not far from the water edge, I found one morning in July, 1909, a plasmodium emerging from beneath a boulder and

beginning the ascent of the overhanging face.. Over the boulder I turned a tight, wooden box. In course of a few hours I found on the summit of the boulder, eight or ten inches high, as fine an *Æthalium* as anyone could wish to see. At the same time the vertical box wall showed plenty of belated, ascending streams, no doubt intended for a second *Æthalium* somewhere within the overturned box.

I have cited this last example because it seems to me to afford the simplest illustration we are likely to have, at least in the field, of the problem with which biophysics has to deal. The plasmodium, *i.e.*, the *Æthalium* of the physicist, in every case, we may assume, the same,—a mass of naked protoplasm, made up of myriads of minute, almost undifferentiated living cells, so associated as to be undistinguishable, at least in life,—is to the physicist a fluid, homogeneous, only slightly more dense than water, if at all; subject to desiccation, but not at all aquatic, requiring for translative movement, not a wet surface, not at all,—such perhaps in a measure prohibitive,—but probably best an invisible film, such as the moist atmosphere of summer might lend to any slightly cooler surface; too dry, doubtless as a matter of course, unfavorable. Of course, there can be no movement here as elsewhere, unless there is resistance, some point d'appui; so having considered the athlete, let us now consider the Matterhorn of his ambition.

Of the three instances of accomplishment, the second, the Friesian episode, may be now neglected as offering no special matters of distinction; if we are to overcome gravitation at all, the living stem of the growing plant would seem to afford highway most practicable, covered, we may suppose, with inequalities, points, projections of every sort as it surely is. This seems really of small advantage, if not a hindrance, to be surmounted; the glaucous glabrous shaft of *Impatiens* found in practice, useful for ascent as any other.

Let us study, then, the lake-side case. Here the journey was made around the blunt edge of an overhanging shelf; the action of gravity not only contrary to the general course of progress, but also in part (vertically) athwart it, as if to pull the climber from its hold. Nevertheless, as stated, and in abundant measure, the

journey was accomplished, no doubt on schedule time. Just why this journey was made it is hard to say, in view of the patent fact that for the plasmodium many another was quite open; much easier of accomplishment one would say, since other courses lay on the level, or even, gravity now favoring, downward amid recesses of rotting leaves and wood, whence the fountain welled. *Æthalium* is surely not geotropic, nor hydrotropic, since it now moved from these directions; neither was it heliotropic, nor even phototropic, in its turning; the gloom of the overshadowing box affected not the culmination of some overmastering push with which the movement started. Thermotropism there may have been, but the heat difference between the upper exposed portion of the boulder and that buried slightly in the forest mould could hardly have been great. In any case, light and wafmth had been for days quite as tempting as in the hour the movement started; the impulse must have some other probably internal physiologic origin; doubtless some change molecular, since the outcome is maturity and fruit.

The biologist might go on to say that since the myxo is reproduced by spores distributed by air currents, or perchance the wind, only such fruits as rise above the general, local level have superior chances in the game of life; success is with those that climb; how the climbing is accomplished the biologist does not say.

But here the physicist may help us much. He steps in to say that every fluid drop or mass meets its environment by a skin, a film in tension, surface-tension, and this in case of your plasmodic stream holds fast sufficient to prevent gravity from pulling your hardy climbers from the Matterhorn, even from the overhanging shelf; while some internal, molecular changes in the cytoplasm itself, doubtless of physiologic import as the biologist suggests, sends the climber up and on to the fulfilment of physiologic function.

But *Æthalium* furnishes a special case. Not every myxo is by any means so rich either in material or equipment, but all aspire; generally speaking, all, even the most minute, show strange ambition, strive to reach upward or outward, if but a little way toward the open air. The behavior of *Æthalium* (most students say *Fuligo*) is strange enough, but the fruiting performance of some

of the more delicate species is more wonderful, more marvelous still.

The keen-eyed Swede, in what he could see with the lenses of a hundred years ago, never ceased his expressions of wonder; they are on every page. According to his theory, vegetation is always a matter of expansion, fruiting of contraction. And so when the plasmodium of some *Trichia, Craterium* or *Arcyria,* oozing up from its hidden nutritive base, began to spread before him in hundreds of thread-like streams covering the whole upper surface of some forest-shaded log or some bed of smouldering leaves, he was charmed; sat watching hour by hour, until over the whole field the threads began to break; rallying points not distant far from one another appearing along each filmy line, he was delighted; contraction succeeded expansion and he was satisfied. But when he returned perhaps on the following day to find that from every point a tiny stem had arisen, each surmounted by a glistening spherule large enough, unless perfectly erect, to bear the little stem to earth, his admiration knew no bounds; he said, "I find nothing more wonderful in all the world of plants."

We of today, seeing so much better and knowing so much more exactly the substance with which we have to deal, may, if we stop to reflect, be no less surprised than was our old-time master. We, far better than did he, know the nature of that thready stream, and may be moved perhaps to greater wonder when it ascends and stiffens several millimeters above the general level, and ends by bearing a sphere upon the expanded summit.

I am free to confess that I watched the procedure long before I learned its methods.

Any such mass of naked protoplasm as that we now discuss shows to ordinary observation a differentiated ectosarc, in appearance not very different from that which it incloses, but still distinct. This ectosarc, then, above occupies no doubt the field of surface-tension. As the physicist has taught us surface- and mass-tension are and remain in relative equilibrium as obedient to some internal force, the currents of the plasmodium push their varied way. But once in the physiologic history of the organism, the tension equilibrium is at any point disturbed in favor of the mass,

the ectosarc at that point yields; the inner cytoplasm follows, usually in direction normal to the basic surface, aided, of course, now by relatively increased surface-tension pressure on each side. As the ectosarc is thus carried up, it becomes, by desiccation perhaps, steadily fixed, from below upward, in position as in form, becomes indeed a capillary tubule closed entirely above by a film of ever-diminishing thickness. Against this continues the mass-pressure of the inner cytoplasm, spore-plasm it shall be, squeezed by increasing surface-tension from below, helped now no doubt by the capillarity of the hollow stem, until the upper remaining membrane, stretched to extreme tenuity by uniform pressure, becomes spherical in shape, and receives, so far as possible, all the cytoplasm from below, ready for conversion into spores.

That we have hit upon the correct solution of our problem is, in this case, further evidenced by the circumstance that sometimes the surface-tension at the base begins to lessen before all the spore-plasm has reached the summit and, equilibrium attained, part of the more vital endosarc remains below, lodged in the hollow stem. Here, with such success as may be, spore formation takes place as in the camera above, and the discerning taxonomist then writes, "stipe stuffed with spores, cells, capillitial threads, etc."

Such are some of the ways of the slime-mould, some of the devices by which it uses earth's various forces and conditions. The botanist tells us what he can see, viz., what his favorites *can* do, and possibly *why* they do it; the man of hydrostatics tells us how, once started, they effect their wonders; but of the molecular energy which still, over and over again, sends flood to fructification, and fruiting back again to flood, by constant, predetermined ways and paths, we still say little; that remains no doubt the general resultant of all those multifarious actions, reactions, attractions and repellings, which everywhere condition the manifestation of what we know and feel as life, and know and say no more.

STATE UNIVERSITY OF IOWA,
IOWA CITY, IOWA

NOTES AND BRIEF ARTICLES

[*Unsigned notes are by the editor*]

Professor Arthur H. Graves, formerly of Yale University, has been called to the Brooklyn Botanic Garden to take charge of the Department of Public Instruction and to devote as much time as possible to mycological work.

Mr. E. J. Butler, Director of the Imperial Bureau of Mycology, Kew, England, who has made a tour of parts of the United States in the interest of pure mycology, visited the Garden on August 18 and sailed shortly afterward for England.

Dr. K. Miyabe, Professor of Botany in the Imperial University at Sapporo, Japan, called at the Garden August 20 and 22 on his return from the Conference of Cereal Diseases held at St. Paul, Minnesota. He sailed from San Francisco September 17, having been in the United States since the first of July.

Dr. E. A. Burt, of the Missouri Botanical Garden, visited the Garden on August 16 to examine certain species of *Clavaria* in the mycological herbarium. He had examined material of this genus at Albany, Cambridge, and elsewhere, and returned to St. Louis by way of New York and Philadelphia.

Mr. A. A. Pearson, Treasurer of the British Mycological Society, visited the Garden early in October before he sailed home to England. He was much interested in our native fungous flora and made several excursions into the woods to collect and study the more conspicuous forms of fleshy and woody fungi.

Dr. G. R. Bisby has applied for leave of absence from the Manitoba Agricultural College at Winnipeg, beginning October, 1921, to accept a position with the British Imperial Bureau of Mycology,

of which Dr. E. J. Butler is Director, with headquarters at Kew Gardens, London. The address is 17 Kew Green, Kew, Surrey, England.

A disease of English ivy caused by *Bacterium Hederae* has been studied and described at Paris by Arnaud (Compt. Rend. for 1920). The symptoms are said to resemble those produced on beans in America by *Pseudomonas Phaseoli.*

Isoachlya, a new genus of the Saprolegniaceae, was described by Kauffman in the *American Journal of Botany* for May, 1921. Three species are included, *I. toruloides* Kauffm. & Coker being new and the other two transferred from *Achlya* and *Saprolegnia.*

Professor Buller has recently sent me a reprint of his article, entitled "Die Erzeugung und Befreiung der Sporen bei *Coprinus sterquilinus,*" which was published in the Jahrb. f. Wissensch. Bot. in 1915. It contains 30 pages of text and 2 handsome double plates.

Mr. Weir finds that not only *Thelephora terrestris,* but also *T. fimbriata* and *T. caryophyllea,* are injurious to coniferous seedlings in the Northwest, owing to their habit of growing up about them and strangling them. See *Phytopathology* for March, 1921.

Miss Bessie Etter has published in *Phytopathology* for March, 1921, an article describing the equipment necessary for making successful field cultures of various wood-rotting fungi. Corn-meal agar and malt agar gave the best results for initial inoculations.

Miss Wakefield, the mycologist at Kew, has recently published a paper of 20 pages on the "Fungi of New Caledonia and the Loyalty Islands." She was assisted by Mr. Massee on certain groups and Mr. Cotton named the Clavarias. Eight new species are described.

Plans for the summer field meeting of cereal pathologists, July 19–22, at University Farm, St. Paul, Minnesota, included excursions to grain fields, elevators and mills in the vicinity of Minneapolis and Fargo. A number of foreign plant pathologists were in attendance.

Professor Massey, of Cornell University, has found by an experiment covering a period of three years that crown canker, *Cylindrocladium scoparium* Morg., causes a loss in the case of Ophelia roses grown under glass of about ten blossoms, or one dollar, per plant. See *Phytopathology* for March, 1921.

Barlot has experimented with various chemicals for color reactions to distinguish poisonous and non-poisonous species of *Amanita* (Compt. Rend. **170**: 679–681. 1920). For example, he found that three deadly species turned black when treated with drops of fresh blood to which potassium ferrocyanide had been added.

A paper by Saccardo, entitled "Mycetes Boreali-Americani," which appeared in the *Nuovo Giornale Botanico Italiano* for 1920, includes notes on 98 species of fungi sent by Weir from the Northwest for determination. Thirty of these species were described as new, most of them in the groups with which Saccardo was familiar.

Investigations of *Cronartium ribicola* in 1920 by Pennington and others brought out two very important points: that species of *Ribes* are often killed by intensive outbreaks of the fungus in a definite area, and that the aeciospores may be blown an indefinite number of miles and cause new infections on *Ribes*. See *Phytopathology* for April, 1921.

A glume blotch of wheat, caused by *Septoria nodorum* Berk., has been under observation for three seasons about Fayetteville, Arkansas, and Mr. H. R. Rosen has now published an account of it in Bulletin 175 of the Arkansas Agricultural Experiment Station. He considers it next in importance to leaf rust as a disease of wheat in Arkansas.

Povah has studied poplar canker, caused by *Cytospora chrysosperma,* in an area near Syracuse, New York, where the trees were weakened by fire, and he finds that in this area 68 per cent. of the poplars were infected and over 30 per cent. killed. Three species of poplars were observed and subjected to inoculation experiments. See *Phytopathology* for April, 1921.

A long illustrated paper on "Cultural Studies of Species of *Actinomyces,*" by S. A. Waksman, appeared in *Soil Science* for August, 1919. This is a notable contribution to our knowledge of soil organisms, the importance of which is being more and more recognized. The paper contains a key to the species of *Actinomyces* based chiefly on biochemical characters.

Mr. Paul C. Standley has called my attention to an article by Hans Schinz, entitled "Der Pilzmarkt der Stadt Zürich der Jahre 1918 und 1919 im Lichte der städtischen Kontrolle," published in Vierteljahr. Naturf. Gesell. Zürich, vol. 56, p. 530. The control of mushroom markets must come in this country as soon as wild mushrooms are offered for sale in any quantity.

A dangerous tobacco disease has appeared in the southern United States, according to Smith and McKenney, apparently due to *Peronospora Hyoscyami,* which was originally described by DeBary from the black nightshade of Europe. This downy mildew attacks the tobacco seedlings in the plant beds, causing great havoc. In Florida, Bordeaux has proven more effective than in Australia, but spraying experiments are still incomplete.

Entoloma albidum Murrill, a species originally described from Stockbridge, Massachusetts, is reported by Dr. H. D. House as the cause of violent illness when eaten by a family of five in Albany late in August, 1921. Specimens were submitted to me for identification. *Entoloma lividum,* of Europe, is dangerously poisonous, and American species of this genus are naturally under suspicion, but few of them have been tested.

"The Fungi of Our Common Nuts and Pits" is the title of an interesting and important paper recently contributed by Dr. C. E. Fairman to the *Proceedings of the Rochester Academy of Science*. Both saprophytic and parasitic fungi are included among the hundred or more species listed. About thirty species and one genus are described as new. The six plates are unfortunately rather poor, but doubtless serve their purpose.

Silver-leaf disease, caused by *Stereum purpureum*, occurs on a variety of trees and shrubs in England, the hyphae of the fungus being always present in the stem and roots of plants that are attacked, but never in the leaves. Infection takes place through wounds. There is a false silver-leaf disease, apparently not due to fungous attack, which must be carefully distinguished. See Bintner in *Kew Bull. Misc.* for 1919.

I am sending under separate cover some specimens of *Calostoma Ravenelii* which I collected on my farm near Conway, Kentucky. The plants were growing in a clay bank along a wooded roadside where the soil had been disturbed within a year or two. The farm lies between the blue grass and the foothills. I had never seen a *Calostoma* before and was wonderfully interested in the find. The collection was made September 6, 1921.—*Bruce Fink.*

A fine specimen of what appears to be the rare *Stereum petalodes* Berk. has recently come in from Las Ninfas, Cuba, collected there by Brother Hioram in midwinter. Professor Burt, to whom a part of the specimen was sent, writes me: "I presume it must be this species, as you determined. I have not seen the authentic specimen of this species at Kew, but should I ever cross the water again I have noted this specimen for comparison with the original."

The correspondence of Schweinitz and Torrey, the two dominating figures in American botany during the early part of the nineteenth century, has been collected and published by C. L. Shear and N. E. Stevens as a memoir of the Torrey Botanical Club, dated July 16, 1921. There is also included a list of the

publications cited, prepared by Florence P. Smith, and biographical notices of persons mentioned in the correspondence, contributed by J. H. Barnhart.

A new leaf-spot of the so-called Egyptian lotus caused by *Alternaria Nelumbii* is described and figured by Enlows and Rand in *Phytopathology* for March, 1921. It appears as very small, smooth, reddish-brown flecks, which increase to a diameter of 5–10 mm. No perfect stage was discovered, but the conidial stage appears to possess great longevity. This disease was first observed by Rand in 1913 at Kenilworth, D. C., and at the New York Botanical Garden.

In Department Circular 177 of the U. S. Department of Agriculture, prepared by Martin and others, a method of treatment is outlined for ornamental pines affected by blister-rust. It is claimed that "infected ornamental pines can be saved by properly cutting out the diseased parts, if the work is done in time. The best results will be obtained in the spring, and success depends upon finding and completely removing the cankers. Tree surgery of this kind can be performed by the owner at small cost."

Farmers' Bulletin 1187 of the U. S. Department of Agriculture, by W. W. Gilbert, deals in a popular way with the chief diseases of cotton and their control. Wilt, caused by *Fusarium vasinfectum*, is controlled by the use of resistant varieties and crop rotation. Anthracnose, due to *Glocosporium Gossypii*, also requires rotation and resistant varieties, care being taken to use only perfectly healthy seed. Bacterial blight requires the same treatment as anthracnose. Other minor fungous diseases are also described in this bulletin.

A new budrot disease of Cannas due to *Bacterium Cannae* is described and figured by Mary K. Bryan in the *Journal of Agricultural Research* for May 2, 1921. Infection takes place through the stomata and spreads through the intercellular spaces of the parenchyma of leaf-blade, petiole and stalk. The disease is most

destructive early in the season, that is, on young plants. It begins in the hothouse and continues in the open beds. It destroys the buds, forms large unsightly spots on the leaves and ruins the blossom clusters by blighting the flower buds or by decaying the stalk. No means of control has yet been worked out.

I received from Dr. Overholts last August a fresh specimen of *Poria semitincta* which was colored a beautiful, delicate lilac (*lilacinus*) on the margin for a centimeter or more, while the hymenium was entirely white or with dirty pale-yellowish-white stains. The following note accompanied the specimens:

"I am sending you under separate cover a fresh specimen of *Poria semitincta* Peck. I do not know how familiar you may be with the fresh coloration in good specimens of this species, and it is worth seeing. The color gradually fades in herbarium specimens, and a collection of October, 1919, with colors as in this specimen has now almost faded out. This is my fourth collection, and I have had it twice from correspondents.'

An excellent professional paper of one hundred pages on "Damping-off in Forest Nurseries," by Carl Hartley, appeared last June as Bulletin 934 of the U. S. Department of Agriculture. Damping-off in nurseries is caused mainly by seedling parasites which are not specialized as to host; *Pythium Debaryanum* and *Corticium vagum* are probably the most important of these. The most serious losses in conifers are ordinarily from the root-rot type of damping-off, occurring soon after the seedlings appear above ground and while the hypocotyls are still soft. The best control method appears to be the disinfectant treatment of the seed-bed soil before or immediately after the seed is sown. Sulphuric acid has been found very useful for conifers, as they are apparently especially tolerant of acid treatment. Broad-leaved tree seedlings rarely suffer seriously from the attacks of damping-off fungi.

The British Mycological Society is interested in a collection of type cultures to be assembled and maintained at the Lister Institute, Chelsea Gardens, London. It is proposed to collect and

maintain cultures of fungi of importance in phytopathology, medicine, veterinary science, technology and soil biology, types useful for teaching purposes and any rare or interesting species. The coöperation of bacteriologists and mycologists is earnestly invited, and in return every effort will be made to supply the needs of applicants for cultures. In the case of fungi it is necessary at present to restrict the collection to fully identified species. Cultures will be supplied on demand, so far as possible, to workers at home and abroad, and, as a rule, a small charge will be made to defray the cost of media and postage. Annual lists of the fungi in the collection will be published in the Transactions of the British Mycological Society.

The *Journal of Agricultural Research* for April 15, 1921, contains an important illustrated article by Annie May Hurd on seed-coat injury and viability of seeds of wheat and barley as factors in susceptibility to molds and fungicides. An unbroken seed coat ordinarily affords absolute protection against attack of living seeds by *Penicillium* or *Rhizopus,* while the location of a break in the seed coat determines the ability of these and other saprophytic fungi to invade seeds, either in the soil or in storage. If the injury is over the endosperm, 100 per cent. fatal infection results when the spores of *Penicillium* or *Rhizopus* are present; but if it is over the embryo, the seeds remain practically immune. The vitality of seeds is also a factor in determining the ability of *Penicillium* and *Rhizopus* to attack them. The damage that will be done to seed wheat by the copper-sulphate treatment for smut and by saprophytic fungi can be predicted by examination of the physical condition of the seed. All these troubles can be reduced by greater care in threshing the seed wheat so that the seed coats are not so badly broken.

According to Korstian and others in the *Journal of Agricultural Research* for May 2, 1921, chlorosis has been the most serious problem encountered in the successful production of coniferous nursery stock at a nursery in southern Idaho. The disease affects all coniferous species grown in this nursery. With chlorosis were

associated poor growth of roots, stems and leaves, failure to form normal terminal buds, and susceptibility to winter injury.

Chlorosis in western yellow pine at the Pocatello Nursery has been definitely corrected by spraying with ferrous sulphate at 10-day intervals. Similar, though less decisive, results were obtained with Douglas fir. A one per cent. solution in amounts sufficient to wet the tops thoroughly proved the most satisfactory treatment. A two per cent. solution ultimately caused chemical injury to practically all the plants. In a region of more frequent rains the stronger solution might be better.

The control of chlorosis in jack pine and western yellow pine at the Morton Nursery in Nebraska by spraying with a one per cent. solution of ferrous sulphate has given such evidence of success that it has been adopted as a part of the regular nursery practice.

"The Relation of Plant Pathology to Human Welfare" was presented by F. L. Stevens as an invitation paper at the Chicago meeting last winter and published in the *American Journal of Botany* for June, 1921. The author deals in a very interesting and convincing way with some of the achievements of plant pathology, as well as with some of the problems still to be solved. The following extracts may awaken interest and lead to a careful perusal of the entire paper:

The magnitude of the annual loss incurred in the United States alone through plant disease in diminution of yield and loss of produce is far greater than it is generally conceived to be. In 1919 the total loss with fifteen principal food products is estimated at nearly a billion and a half dollars. Among the late continental arrivals is the pine blister rust, which is under such headway that it seems to be impossible of extermination. The value of the susceptible pines is such that the loss may readily reach a hundred million dollars. The chestnut-bark disease caused a loss of $25,-000,000 from 1904 to 1911. Much more serious is the loss to be borne as it invades the great chestnut forests of the Appalachians Citrus canker, imported from Japan about 1910–11, bids fair to ruin large industries. As increased long-distance communication gives intercontinental transport to disease, so congestion of crop

population creates a bridge by which the casual organism may more readily pass from plant to plant or from farm to farm. In these two conditions, facility of transportation and congestion of crop, we find, to a large degree, explanation of the fact that plant diseases are more prevalent now than formerly.

What is the nature of the return that plant pathology has given? The achievements may be summarized briefly as falling within seven great categories demonstrating the value of: protective applications, sprays and dusts; excision; seed steeps; general sanitation leading to diminution of infective material; breeding for disease resistance; modifications of agricultural practice; quarantine restrictions. Of all the categories mentioned, perhaps the least dependent upon science and the most empirical is that relative to disease resistance, since some of our most valuable resistant varieties have been given to us by farmers, while many of the most susceptible have been eliminated naturally. During recent years, however, knowledge of Mendelism and of biologic specialization has added a very important, truly scientific aspect to this somewhat empirical subject.

It is to be observed that the great discovery of the parasitism of the fungi and the founding of bacteriology and the development of its methodology, together with the early foundations laid through the years in histology, mycology, taxonomy and physiology, have furnished the bases on which plant pathology has made its advance. Aside from these there have been few, if any, great fundamental contributions. The problems of disease resistance and wherein it lies are obviously important. Enzymes and toxins will repay much study. That group of mysterious diseases including the mosaics and peach yellows holds a secret the discovery of which may well be revolutionary in pathology. But since the problems now before us are more intricate than those of the past generation, they demand concentration, larger breadth of equipment, longer periods of sustained research on a given problem, in a word, greater specialization, and this often needs to be accompanied by coöperation of widely separated branches of science or of distinct sciences.

In Research Bulletin 48 of the Agricultural Experiment Station of the University of Wisconsin, devoted to Fusarium Resistant Cabbage, Professor Jones and his co-workers summarize the present status of this important series of investigations as follows:

"It is evident that individual variation in degree of susceptibility or resistance to Fusarium has been found to occur with every variety of cabbage tested on 'yellows sick' soil. Experience to date justifies our confidence that this resistance is due to heritable differences and that, therefore, through the selection of such resistant heads from 'sick' soil, a Fusarium-resistant strain may be secured of any of the standard cabbage varieties. Our experience indicates, moreover, that through careful and repeated selection this resistance may be combined with any of the other desired qualities of the standard commercial varieties, such as season of maturity, length of stem, tenderness of leaf, shape and compactness of head. In other words, resistance does not seem to be incompatible with any other of the commonly recognized variables of the cabbage. All our experience indicates that Tisdale's conclusions relative to the flax wilt hold true for the cabbage, that resistance is probably determined by multiple factors. The degree of resistance is, therefore, due to the combination of these, and in all cases in our experience it is partial or relative, not absolute. Moreover, this explanation is consistent with our experience that after proceeding to a certain stage with our present methods of selection little or no further progress as to disease resistance is made. This is also consistent with our general experience that the best results have in each case been secured through growing a selected head in isolation and thus securing seed through self-pollination, but that when the benefits were once secured in this way with our best selections mass culture has been followed to advantage.

"Our plan of procedure, justified alike by theory and practice, is as follows. After securing a strain showing a satisfactory degree of resistance, combined with the other desired characteristics, we release it for commercial distribution. Thereafter our interest is primarily confined to such coöperation as is required for the maintenance of these essential standards. To this end we con-

tinue to grow each year a few hundred plants of each of these types in trial rows on soil that is 'sick,' *i.e.*, thoroughly infested with the cabbage Fusarium. From these plants further selections are made with the aim of maintaining the best standards both as to type and disease resistance. Of course, there is opportunity for minor gains in this way, but our experience has not indicated that much improvement is to be expected in this direction. The surplus seed thus obtained is placed in the hands of the local cabbage growers' committee for commercial increase in such manner as will best maintain general standards of excellence."

REVIEW OF KLEBAHN ON LIFE HISTORIES OF ASCOMYCETES

Haupt-und Nebenfruchtformen der Askomyzeten. Eine Darstellung eigener und der in der Literatur niedergelegten Beobachtungen über die Zusammenhänge zwischen Schlauchfruchten und Konidienfruchtformen, von Heinrich Klebahn. Erster Teil Eigene Untersuchungen, Leipsig, Verlag von Gebrüder Borntraeger, 8. 1918, pp. 395. text figs. 275.

This is one of the papers prepared for the memorial volume to Dr. Ernst Stahl in celebration of his seventieth birthday. The author is already well known for his investigations of the life histories of ascomycetes as well as rusts.

As an introduction, previous work on this subject from the Tulasne Brothers and Fuckel down is briefly reviewed. The life histories of the fungi covered in this part of the work, including about 40 species and varieties, mostly pyrenomycetes, have been determined or verified by the author. The second part, which is promised later, is to cover similar work of other investigators on this subject. This work will be of great value to all mycologists and pathologists, as the various papers which have been published on life history studies are much scattered and frequently inaccessible to students and sometimes to investigators. Most of the life histories reported are based upon pure cultures from ascospores. In many cases inoculation experiments were also made. The genus *Mycosphaerella* is taken up first and the life histories of 7 species, occurring on various hosts, are described. In some of the species *Septoria* was found to be the pycnidial stage; in others the form produced was *Phleospora*. The author suggests

that the form genera *Septoria* and *Phleospora*, though separate, are very closely related, and hence keeps their ascogenous forms together. In certain other species of *Mycosphaerella*, as *M. punctiformis, M. Fragariae* and *M. maculiformis*, *Ramularia* is shown to be the conidial form; while in other species, as *M. cerasella*, a *Cercospora* is produced. The author concludes, therefore, that in spite of the morphological similarity of the ascogenous forms of the various species of *Mycosphaerella* they are no more closely related than their corresponding lower spore forms. *Cercospora* is said by the author to be closely related to *Ramularia*, but is considered distinct in lacking chains of conidia and in the color of the mycelium when young. In culture *Cercospora* is said to be strikingly different from *Ramularia*. On account of these differences in the lower forms found in the species of *Mycosphaerella* studied, three new generic names are proposed: *Septorisphaerella*, *Ramularisphaerella* and *Cercosphaerella*.

This is an innovation in nomenclature which needs serious consideration. The purpose of these compound names is evidently to suggest at once the life history of the fungus by combining the names of the perfect and imperfect stages. In the first place this plan seems to set aside all claims of priority for previous generic names and apparently proposes the substitution of entirely new names for genera as fast as their life histories are known. This alone is a radical departure from established usage. It would also lead to frequent violation of the rule against sesquipedalian names. To be consistent in the application of this method it would be necessary to combine the names of the various form genera in cases where 3 or 4 spore stages or form genera are known to belong to the life history of a single organism. The combination of so many different generic names in one would evidently be impracticable. Supposing, however, that the plan were feasible; in the present state of uncertainty as to the types of genera and the application of generic names such combinations would be uncertain in their significance and would not mean the same thing to different mycologists. The reviewer is forced to conclude, therefore, that however laudable the author's purpose in adopting these new names, there is much more to be said against the plan than for it.

Another fact might well be considered in this connection. The author recognizes that there are species of *Mycosphaerella* which have been found to have *Ascochyta* or *Diplodina* and *Cylindrosporium* as lower spore forms, and he also finds *Phyllosticta* pycnidia present in species of his *Septorisphaerella* and *Ramularisphaerella*. The experience of the reviewer has shown that in *Glomerella, Melanops* and other ascomycetes the same species will sometimes produce one form of conidial or pycnidial fructification and at other times another form, and occasionally two or three forms in succession in a single culture. It appears, therefore, that, in pure cultures from single ascospores, there is at present no certainty of securing all the spore forms belonging to the life history of the organism in a single culture, or in a few cultures. Sometimes no lower spore form is obtained, as the author indicates in some of his species, and he concludes as a result that the species possesses no such form. He cites in support of this conclusion the fact that in closely related rusts certain spore forms are lacking, whereas in others they are present. Evidence of this sort is entirely untrustworthy in the reviewer's opinion. It seems much more reasonable to expect that, if at one time we obtain a *Ramularia* or *Cercospora* and at another time, from the same or a very similar species, obtain a *Septoria* or *Phleospora,* both the conidial and pycnidial form may belong to both species; but for some unknown reason have not both developed in either case. Potebnia, a former worker in Klebahn's laboratory, also expresses this view in discussing *Mycosphaerella cerasella,* in which only a *Cercospora* type was produced. He says that by analogy we must assume the existence of the *Phleospora-Septoria* type in this species also. The reviewer has demonstrated (in MSS.) that such cases occur in *Melanops,* where in one series of cultures from ascospores only a *Dothiorella* is produced and in another series from the same species, so far as can be determined by morphological characters, and from the same host, only a *Sphaeropsis* or *Diplodia* spore form is produced.

It is a notorious fact that ascocarps are rarely produced in culture when the conidiospores or pycnospores are used as a starting point; but one would scarcely feel justified in concluding from

this that all of the forms behaving in this way are autonomous and have no ascospore stage. Until we know vastly more about the factors which determine the sequence and development of the various spore forms, it is futile to predict that, when cultures from ascospores produce ascocarps directly, the species lack lower forms; or that, when they produce pycnidia or conidia, this is the only lower spore form they possess.

The author very aptly remarks that there are many unknown factors yet to be determined in regard to the behavior of these organisms under cultural conditions.

The life histories of various species of *Gnomonia* follow, the author including under this genus what have been called *Ophiognomonia, Gnomoniella, Linospora* and *Hypospila*. The conidial forms of most of these species are referred to the form genera *Gloeosporium, Marssonina, Asteroma* and *Leptothyrium*. The only conclusion he is able to draw from the great variety of lower spore forms obtained is that, if the various intermediate states which occur between conidial and pycnidial fructifications are recognized, it may be said that the lower forms of *Gnomonia* all belong to the Melanconiaceae.

It seems evident that much more study and comparison of the morphological characters and the correlation of further life history studies are needed in order to determine the generic and specific relationships of the species and genera discussed.

In conclusion the author discusses and illustrates the life histories of several discomycetes, including *Entomopeziza Soraueri, Pseudopeziza ribis, P. Populi-albae* and *P. salicis*. As a result he concludes that species of *Gloeosporium, Marssonina* and *Entomosporium* are conidial conditions of these fungi, and that also species of *Gloeosporium, Marssonina* and similar fungi belong to species of *Gnomonia*. He, therefore, is of the opinion that the relation between these discomycetes and the pyrenomycetes mentioned is very close.

The reviewer believes, however, that this relation is not nearly so close as suggested, and that the author's conclusion is perhaps due to a misinterpretation of the form genera mentioned. *Gloeosporium*, for example, as used by Saccardo and others, includes a

most heterogeneous group of spore forms having only the most superficial and general characters in common, and the large number of so-called species when carefully studied morphologically and in culture are found to consist of very different organisms which should be placed in very different genera on the basis of a thorough knowledge of their morphological characters alone.

The author expresses the belief, however, that an improvement of the present taxonomy of the imperfect fungi can only be expected when their connection with their perfect stages is known. The phytopathological importance of such knowledge is also indicated, as the ascogenous form found on dead plant parts, and hence usually regarded as a saprophyte, may carry the parasite over winter and be the source of new and unsuspected infections in the spring.

As to which was the primitive spore form, he says: "Little is known as to whether the original form of fructification was ascogenous or conidial." Brefeld's views regarding the relation of asci to sporangia he does not consider tenable in the light of our present knowledge. The evidence thus far accumulated by the author and others would seem to justify the belief that further studies of the life histories of the ascomycetes and of the morphological and cultural characters of the various spore forms or stages will furnish most important clues to the taxonomy and phylogeny of this great group of fungi and make it possible to present a more natural system of classification than we have at present.

The numerous clear text figures given are indispensable in interpreting the work and getting exact ideas of the forms discussed. The text is less involved and more easily read than that of many German scientific writers. It is to be hoped that the author will continue these valuable studies and that the second part of the work may soon appear.

C. L. SHEAR

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INDEX TO VOLUME XIII*

New names and the final members of new combinations are in **bold face type**

* It has been considered unnecessary to include here the species listed in the four following articles, since they are already indexed or specially listed.

Arthur: Memoranda and index of cultures of Uredineae, 1899–1917. See p. 237.

Diehl: The fungi of the Wilkes expedition. See p. 40.

Overholts: Some New Hampshire fungi. See p. 26.

Zundel: Smuts and rusts of northern Utah and southern Idaho. See p. 179.